THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL

VOL. 50 Thursday, May 3, 1934 No. 924

PUBLISHED WEEKLY

Subscription Terms: 15s. per annum.
Foreign and Colonial: 17s. 6d. per annum.
All Subscriptions are payable in advance.

All Communications to be addressed to the Editor, the Advertisement Manager, or the Publisher of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2

Telegraphic Address: "Zacatecas, Rand, London."
Telephone: Temple Bar 3951 (5 lines).

Contents

	PAGE
Physical Data	281
Cheap Ticket Reflections	281
A Foundry in a Garden	282
A New Electrode for Welding Cast Iron	282
Random Shots	282
The Thermal and Electrical Properties of Cast Iron	283
Rainwater Goods and Baths	285
American Society for Testing Materials	285
Design, Patternmaking and Moulding	286
Institute Elects New Members	287
The Steel Castings Report	288
Reactions Between Pig-Irons and their Slags	290
German Foundrymen's Technical Association	290
To Present Exchange Paper	290
Book Review	290
This Week's News in Brief	292
Trade Talk	292
Obituary	292
New Companies	292
Company Reports	292
Personal	292
Contracts Open	292
Raw Material Markets	294
Midland Pig-Iron in South Wales	294

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION

Institute of British Foundrymen

PRESIDENT: 1933-34
C. E. Williams, "Coniston," Cefn-Coed Road, Penylan, Cardiff.

LIST OF SECRETARIES—
General Secretary: T. Makemson, St. John Street Chambers, Deansgate, Manchester. London Office: 49, Wellington Street, London, W.C.2.
Birmingham, Coventry and West Midlands: L. W. Bolton, 21-23, St. Paul's Square, Birmingham.
Sheffield: T. R. Walker, 33, Ladysmith Avenue, Nether Edge, Sheffield.
Scottish: J. Bell, 60, St Enoch Square, Glasgow.
Lancashire: J. E. Cooke, 1, Derbyshire Crescent, Stretford, Manchester.
London: H. W. Lockwood, Stewarts and Lloyds, Limited, Winchester House, Old Broad Street, London, E.C.2.
Newcastle-upon-Tyne: J. W. Eckford, 4, Mosley Street, Newcastle-upon-Tyne.
East Midlands: H. Bunting, 82, Otter Street, Derby.
West Riding of Yorkshire: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth: J. J. McClelland, "Clydesdale," Dover Street, Bilston, Staffs.
Middlesbrough: F. A. Harper, Station Chambers, Middlesbrough.

National Ironfounding Employers' Federation

President: J. Smith, Smith & Company (South Shields), Limited, Nile Street, South Shields.
Secretary: Harold G. Judd, C.B.E., 8, Frederick's Place, E.C.2.

Foundry Trades' Equipment and Supplies Association

President: R. H. Brackenbury, 13, Victoria Street, London, S.W.1.
Secretary: K. W. Bridges, Grand Buildings, Trafalgar Square, London, W.C.2.

Welsh Engineers' and Founders' Association

President: W. E. Clement, Morfa Foundry, New Dock, Llanelly.
Secretary: E. J. Griffiths, 2, Royal Metal Exchange, Swansea.

BRITISH CAST IRON RESEARCH ASSOCIATION

The Registered Office and Laboratories of the B.C.I.R.A. at:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Central 1885. *Telegrams: CIRA*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332)

Physical Data

Some years ago we drew attention to the necessity of obtaining reliable and accurate physical data in order to assist in the solution of many of the metallurgical and engineering problems with which present-day industry was confronted. We welcomed at that time the investigations, which had been carried out and which were being undertaken with a view to elucidating those problems from a purely physical point of view. What was said then has been justified in the demand which certain research organisations have made for information regarding the physical properties of the metals and alloys whose behaviour they are investigating.

The Heterogeneity Committee of the Iron and Steel Institute and of the National Federation of Iron and Steel Manufacturers in their Second Report drew attention to the lack of information on the thermal and other properties of ingot-mould irons. They considered that more information was required regarding certain physical properties if all the factors incidental to the production of the perfect steel ingot were to be dealt with. To provide the information required, researches were initiated by the British Cast Iron Research Association on density, specific heat, thermal expansion and dilatation properties, and thermal and electrical conductivities. These investigations were carried out on used and unused ingot moulds, and the results obtained were embodied in Section VI of the Fourth Report of the Committee.

The necessity for similar information with regard to steel has also been referred to recently by another Committee appointed by the same bodies, namely, the Steel Casting Committee. In their First Report published last year reference is made to the need for more information regarding the physical properties of steel at or near its melting point, if satisfactory advances are to be made in solving the problems connected with steel founding. In discussions which have taken place on the above Report this point has been emphasised, and it has also been stated that similar information is required regarding the moulding sands used in such work if success is to be attained. We understand that such investigations have now been started on behalf of the Committee.

The Technical Committee of the Institute of British Foundrymen have also been interested in the question of physical data. The Sub-Committees on Cast Iron and on Non-Ferrous Metals have assembled all the available published data on cast iron for: specific gravity, specific heat, latent heat of fusion, thermal conduction, thermal expansion, and electrical conductivity. Such data has been tabulated and checked, and will shortly be published, and ought to be of considerable value to all those engaged in iron and steel foundry practice. So far as moulding sands are concerned, this has been very fully dealt with by the Sands Sub-Committee and was made available to foundrymen at the Cardiff meeting.

During the last few years various investigations on the physical properties of metals and alloys have also been carried out by independent workers in Britain, on the Continent, in Japan, and the United States, and have been made available through Papers read at technical societies and institutions. These investigations have advanced considerably our knowledge as regards the behaviour of such materials, and to the difficulties encountered in their manufacture and various industrial applications. Scientific information and methods are becoming increasingly used in all branches of industry, and it is of satisfaction to note that in the accumulation and use of scientific data the foundry and allied industries are not lagging behind, but are keenly interested and maintaining a lead.

Cheap Ticket Reflections

The accounts published in our last issue of the forthcoming conference next autumn in Philadelphia reminded us that between now and then the summer will be here, so we occupied part of the week-end with a desultory examination of the attractions offered by various holiday resorts through the medium of the Sunday Press. We were astonished to find the reductions being offered to foreigners visiting the countries enjoying a dictatorship, particularly Italy and Germany. In those countries the internal railway fares are being cut to something like one-third of their normal figure. We presume that this involves a loss which is made up in some way or other by the taxpayer. At the risk of appearing to look a gift-horse in the mouth, it is impossible to avoid speculating as to why this is done. Has the traffic fallen off so much? It would be expected, in part because of the depression and in part because the economic nationalism which is afflicting Europe so much is bound to result in a tendency towards a smaller interchange of visits and hence of ideas. We in the foundry industry have encouraged this so much in the last ten years that the new tendency is very regrettable. But we fear that it is inevitable. A situation had been created out of which, through personal friendships, interchange of correspondence or in other ways, one country was able rapidly to take advantage of developments in another. The damping of this interchange is retrogressive, and we doubt whether very cheap internal travelling will counterbalance it, because the bulk of the cost of getting to a country and back again is large compared with the cost of getting from the frontier to destination when the country is reached. In addition, the English people are politically very tolerant and broadminded. They may have strong views, but they have learned that others may have views equally strong and different without being any the worse as citizens. Consequently, they have a feeling, which is none the less there because it is unexpressed, of hesitation in visiting a country the spirit of which has changed from one of comparative freedom to one of dragooning and regimentation of people and Press, and especially small minorities. To herd masses of people through a prearranged schedule at cheap rates is useful up to a point, but the understanding international traveller whose business does not compel him to go and who is free to choose, is unlikely to be persuaded by a cheap ticket, which seems inadequate as a cure for economic nationalism.

A Foundry in a Garden

By Barrington Hooper, C.B.E.

Foundries somehow are automatically associated in one's mind with smoke, grubbiness and the more unpleasant characteristics of modern activity. It may not be known to the many thousands of visitors who have sampled the delights and joys of a winter holiday in Madeira that on this beautiful island there is a foundry—a busy foundry—complete in miniature with all the attributes of the big foundry works with which we are so familiar in this country.

"A foundry in a garden" well describes the delightful situation of the Madeira Engineering Company's foundry at Funchal. It is safe to say that no works plays so important a part in the life of this island paradise as this small but efficient foundry presided over by Mr. J. H. Quicke.

Madeira as a holiday resort, particularly in the winters of latter years, has vastly increased in popularity as being the nearest spot to this country where summer weather can be completely relied upon throughout the year. Bathing at Christmas and on New Year's Day, and a temperature that permits of sunbathing throughout the period of our fog and snow, attract visitors in increasing numbers, more especially of recent date, when the rate of exchange plays so important a part in deciding our sunshine winter trip.

One would not expect to find in Madeira any close association with the foundry industry, and it was surprising to the writer, therefore, when visiting the island this February, to find so many people he was in the habit of meeting in England in connection with iron, coal, steel and foundry practice.

To those knowing the foundry industry in this country the model works in Madeira presents many interesting features. Situated right on the coast of the Bay of Funchal, the foundry has to adapt itself to a vast variety of tasks. Odd jobs for the Municipality of Funchal, such as manhole covers, bits and pieces for various plant and machinery on the island, castings for ships—there is a shipyard within the precincts of the foundry—and when all other work is slack they fill in their time casting stewpots for the peasantry. Interesting work, this stewpot making—nearly 50 per cent. waste was the order before the present manager took charge. He is an Englishman of delightful and inspiring personality. Every road from Funchal goes uphill, most gradients being from 1 in 6 to 1 in 3, and Mr. Quicke's charming house stands high upon the mountainside, bathed in continuous sunshine and overlooking the blue bay of Funchal, with its mass of shipping. From his house, maybe a matter of a mile and a-half to the foundry, the road is by way of banana groves and sugar plantations, and when Mr. Quicke, who is not only a foundryman but the engineer to the island, drives in his English car from his bungalow among the bananas to his foundry on the seashore, he never knows from day to day what his next problem is going to be.

There has been much progress of late in Madeira—many new roads are being constructed, and of course the bridges are built by Mr. Quicke, while much of the necessary metalwork has seen the inside of his foundry. A row of shops outside Reid's Hotel came into being under his direction. The visitor will be shown boats and launches, and indeed craft of all shapes and sizes, built in the shipyard controlled by him, the metal parts coming from the foundry.

It must be strange for a man fresh from England and mass-production foundry methods, accustomed to working day in and day out on one specific problem, to realise how with comparatively few implements and in limited space, a foundry can turn out so vast a variety of castings.

I hear that a new industry has been added to the Madeira foundry, also, of course, presided over by the same engineer; that is, rubber manufacturing. Mats of every shape and colour are now being made in increasing quantities. Rubber is a big industry in Madeira, for owing to the nature of the rock on which one walks, leather-soled shoes are practically useless. To attempt to climb the hilly roads in them is to court disaster. To climb the greasy pole would be simple by comparison. So the Englishman who goes unprepared, and with leather shoes, to Madeira, hastens to the stores to buy rubber-soled boots.

One could talk at great length on the variety of products made in the foundry and the industries clustered round it, but I recommend rather that you should find an excuse to visit for yourself this island of sunshine. The "dustless island" it has been called, for there is no dust on the roads of Madeira. Others call it the "island of flowers," for there are flowers in bloom there all the year round. But what interested the writer most was Mr. Quicke—kindly thoughtful and so busy that one wonders he has time to do the kindly acts that so justly make him one of Funchal's most popular citizens.

A New Electrode for Welding Cast Iron

A new electrode that solves cast-iron problems and is the result of many years of laboratory research and experiment has been developed and placed on the market by the Lincoln Electric Company. One of the outstanding advantages of the new electrode, which is known as "Ferroweld," is the remarkably low heat with which it can be used, thus reducing to a minimum the possibility of either the weld or the work cracking. The electrode has a steel core surrounded by a heavy flux coating of uniform thickness, providing a shielded arc. This shielding of the Ferroweld arc protects the weld metal from contamination by the elements of the ambient atmosphere. Thus, the weld metal is deposited under the most ideal conditions. The new electrode is produced in one size only, $\frac{1}{8}$ in., in 14-in. lengths. Its manufacture is limited to this one size to ensure its use with low heat. Ferroweld provides a solid, dense weld of a greater tensile strength and ductility than ordinary cast iron. Due to the extremely low current with which it can be used, the hardening effect usually present along the line of fusion is materially reduced, thus making a weld with this electrode much more machinable than with most electrodes.

The new electrode should be used with reversed polarity, *i.e.*, with the work negative and the electrode positive. The current should be about 80 amps. d.c. At this low current a sound weld with a good bond with the cast iron is produced. The welding should be done intermittently. Not over a 3-in. bead should be laid down at one time. After each bead is welded, it should be immediately peened lightly, thoroughly cleaned, and allowed to cool somewhat before the next bead is deposited. Care should always be taken to see that repair work in machinery castings is thoroughly clean, and also that the work is not allowed to get too hot.

Nickel Cast-Iron Dies

Nickel cast-iron dies are being used by practically every important motor manufacturer and body builder in the Detroit area, and the Central Iron Foundry of that city recently produced a set of fender dies weighing nearly twenty tons from a semi-steel mixture containing 1.5 per cent. nickel and 0.5 per cent. chromium. In some cases nickel cast iron has proved to be superior to more expensive die steels, and one manufacturer states that his nickel cast-iron dies have already produced over a million cold stampings, whereas the average production from cast-steel dies was about 500,000. Nickel cast-iron dies are strong, wear-resistant and readily machinable; they will take and retain a high polish, and a good finish to the stamping is thus secured.

Random Shots

Words are like wines to the extent that the older they are, the better we like them, and, moreover, there is a flavour about some words which makes it positively enjoyable to roll them on the tongue. At least, so it seems to "Marksman," but he is fully prepared to admit that certain words are more apt to twist the tongue than to roll off it! All trades have their own vocabulary, some richer than others, and "us ferrous chaps" have no reason to complain that our trade terms and phrases are lacking in biff, bite or beauty. In fact, one may say that all occasions are catered for, and the all-in-all foundryman can give expression to many and varying moods without departing from his trade jargon.

* * *

"Marksman" has been mixed up with the foundry trade long enough to state with conviction that honesty is the best policy (quarterly premium payments can be arranged), and he therefore frankly admits that in the hurly-burly of his chequered career the simple word "blast" has stood out among all others in the technical terms of his trade. Unlike the boarding-house bread, it never gets stale, and whether murmured *sotto voce* or bellowed in a booming bass, it may be relied upon to bring instant relief to the sufferer. In "Marksman's" humble judgment, therefore, "blast" starts odds on in the foundry stakes. For quieter moments "bosh" has its uses, and is not so likely to get you into a pickle, while no one can grumble if you state succinctly that something or somebody is the "elastic limit." Within the limits of our own trade brotherhood there would not perhaps be any harm in referring to a foundryman as a mouldy fellow, but "Marksman" feels that this phrase might well be misunderstood outside the ranks of our own open-hearthéd selves. Be a little circumspect, therefore, in personal reference, for otherwise you may in bitter self-reproach be compelled to pronounce those letters sacred in the ears of every good foundryman, I.B.F. And, as a matter of fact, you will be!

* * *

There are times, probably plenty of them, when life appears all flux and no flow, and humanity in the bulk seems to infect you with a chill far beyond anything conceived by the most skilful roll-maker. Then is the time to show your temper (and grain size) by exclaiming in a hearty voice, "We are all good twyers." As a matter of fact, it is no good being anything else to-day, for there are very few soft billets, either round or rectangular, in the foundry trade, and, if your job is a hard one, it is pretty doubtful whether events will permit you to anneal it into something cushy.

* * *

Does spring find you on gardening intent and suffering from that curious malaise of the mind which, although sound in wind and limb, promotes a seedy feeling? Lean on your lingo then and meditate upon "blooms." A warning, however, is necessary here to horticultural enthusiasts who may be looking for words of ferrous origin to express themselves. You recollect the phrase "fatigue limit"? Good. Well, forget it, for there is no limit to your fatigue if you persist in being a gardener. With the prospect of warmer weather ahead, ponder rather on matters appertaining to heat. "Heat tinting," for example, which suggests a mottled countenance, and again (and for preference) "heat-treatment," which indicates clearly enough the necessity for liberal doses of liquid. "Marksman" himself favours the phrase "hot shoot," which is defined as "unable to be worked in a hot state." Them's my sentiments!

Marksman.

The Thermal and Electrical Properties of Cast Iron

By J. W. Donaldson, D.Sc.

In the casting of iron and steel, whether in the form of ingots or castings, many problems present themselves to the iron or steel founders. Towards the solution of these problems many investigations have been carried out in many branches of science and practical work. Among such investigations have been work relating to the physical changes taking place during such operations, and to the determination of more accurate data for such changes. Determination of such data has also been extremely valuable in the engineering and other industries which are allied in various ways to the foundry industry.

In THE FOUNDRY TRADE JOURNAL of July 2, 1931, the author dealt with the thermal and electrical conductivities of cast iron, and reviewed the work which had been done to obtain accurate values for those two properties. It is now proposed to review and discuss not only the further work which has been done on the thermal conductivity and electrical resistivity of cast iron, but also the data which has been determined for the physical properties of specific heat and thermal expansion, for a knowledge of accurate constants for those two latter properties and for thermal conductivities which are considered to be of value to foundry metallurgists in dealing with many casting and solidification difficulties.

Thermal Conductivity

In 1930, from the investigation which had been carried out, it was shown that the thermal conductivity of grey cast iron varied from 0.110 to 0.140 and decreased with increase in temperature. The value obtained depended to a certain degree on the composition, silicon, manganese, nickel and vanadium lowering the conductivity and chromium and tungsten raising it. The conductivity of white cast iron was considerably lower from 0.030 to 0.080 and was also affected by composition. Heat-treatment which produced graphitisation either in white or grey iron influenced the heat-conducting power of the material, the value being increased.

In 1931, the thermal conductivities of a series of commercial cast irons between 0 and 100 deg. C. were determined by Thyssen, Marechal, and Lanearts,[1] using a modified Despretz method of determining relative conductivities. Their main conclusions were that the conductivity rises with an increase in the phosphorus content, but that it was not possible to determine the influence of other elements. They also state that the conductivity diminishes with diminishing diameter of test-bars, due to a diminution in the size of the graphite flakes, and that the thermal conductivity is proportional to the diameter of the test-bars.

The conclusions put forward by these investigators, however, are open to serious criticism. Their method of testing is an indirect one and they make certain assumptions regarding it which are not altogether justifiable. The thermal conductivity values obtained ranged from 0.178 to 0.302, which are considerable, when the work of other investigators is considered. They also experimented with only five irons in which the five elements, carbon, silicon, sulphur, phosphorus and manganese, varied in no regular manner, and they deduced the influence of these various elements on the thermal conductivity from the results obtained from these five irons. To obtain results as to the influence of any one element, it is necessary to work with a series of irons of similar composition, in which only the one element varies, hence conclusions derived for four elements from five irons of varying composition cannot be accepted.

In the 4th Report of the Heterogeneity Committee of the Iron and Steel Institute,[2] published in 1932, Section VI deals with ingot-mould materials, and includes work on the thermal properties of ingot-mould irons. This work was undertaken, due to lack of information on the thermal properties of such materials, and was carried out by the British Cast Iron Research Association, with whom the writer co-operated in making the thermal-conductivity determinations.

Tests were made on samples taken from three ingot moulds, two of which were tested before and after use, and the third in its used state. In the used mould, tests were made at the top and bottom of the mould. The composition of the moulds varied to a slight degree, but were within the limits, carbon 3.43 to 3.77 per cent., silicon 1.81 to 2.46 per cent., manganese 0.43 to 0.78 per cent. and phosphorus 0.29 to 0.42 per cent. The three irons had microstructures which were very heterogeneous, but which were in general characterised by the coarseness of the graphite flakes and an almost wholly pearlitic structure.

Thermal-conductivity measurements were made on the various irons over a range of temperatures up to 425 deg. C. A summary of the results obtained is given in Table I, and shows

TABLE I.—*Thermal Conductivities of Ingot Mould Iron (Donaldson).*

Cast iron.	As-cast.		After use.	
	100 deg. C.	400 deg. C.	100 deg. C.	400 deg. C.
1 ..	0.095	0.087	0.103	0.092
2 ..	0.103	0.096	0.107	0.098
3T ..	—	—	0.087	0.080
3B ..	—	—	0.097	0.089

the thermal conductivities of the irons at 100 deg. and 400 deg. C. respectively. The values obtained are low when compared with values obtained from irons of somewhat similar composition and structure tested previously. Two cast irons containing 1.48 and 1.91 per cent. silicon, respectively, had thermal conductivity of 0.123 and 0.111 at 100 deg. C. and 0.108 and and 0.103 at 400 deg. C. These two irons on machining gave sound test-bars in contrast to the test-bars of the ingot-mould irons, which were all covered with a large number of small pin-holes. Microexamination also showed the graphite of these irons to be in a much finer state.

The conclusions to be drawn from these tests on ingot-mould irons are that the thermal conductivity values are lower than those usually obtained from grey iron of somewhat similar compositions and structures, cast under ordinary foundry conditions, for engineering and other castings. The falling-off appears to be due to the nature of the irons, which are lacking in denseness and are of a more open nature than normal grey-iron castings, rather than to the slight increase in the silicon content and the increasing coarseness of the graphite flakes, although both these factors would also have a slight influence. The heat-conducting property of these irons increases during the life of the mould, and this is no doubt due to the heat-treating or annealing influence of the molten steel on the material producing decomposition of the pearlite into ferrite and graphite with a consequent increase in conducting power, as has been shown in previous investigations.

In the various investigations which have been carried out on the thermal conductivities of ferrous alloys, it has always been shown that composition has an important influence on the heat-conducting property. Structure, however, exerts a considerable influence in some alloys, particularly cast iron, and may even counteract the effect of composition. This is due to the fact that the relative conductivities of ferrite and cementite are respectively 0.174 and 0.017, and consequently free ferrite is a much better conductor of heat than eutectoid pearlite.

This has been definitely established by recent work carried out by the author[3] and embodied in a Paper to the Iron and Steel Institute in September, 1933, where results are given for a wrought iron, five carbon steels, a black-heart and a white-heart malleable cast iron, and five special cast irons. The wrought iron tested was a commercial wrought iron containing a fair proportion of slag and having essentially a ferritic structure. The five steels included three hypo-eutectoid steels with increasing carbon contents and consequently increasing proportions of pearlite and diminishing proportions of ferrite, a eutectoid steel with a wholly pearlitic structure and a hyper-eutectoid steel with a pearlitic structure and free cementite at the grain boundaries. A similar variation in structure was obtained in the malleable irons, the white-heart iron consisting of pearlite and temper carbon and the black-heart iron of ferrite and temper carbon.

Three of the five special cast irons tested were specially prepared. One contained 1.87 per cent.

TABLE II.—*Thermal Conductivities of Iron Alloys (Donaldson).*

Alloy.	Composition.		K.	
	C.	Si.	100 deg.	400 deg.
W	Trace	—	0.175	0.168
CS1 ..	0.10	—	0.161	0.152
CS2 ..	0.26	—	0.134	0.128
CS3 ..	0.44	—	0.129	0.121
CS4 ..	0.92	—	0.120	0.115
CS5 ..	1.09	—	0.118	0.112
B.M. ..	2.36	1.03	0.150	0.139
W.M. ..	2.80	0.39	0.114	0.106
CI.1 ..	2.89	1.87	0.112	0.105
CI.3 ..	2.87	2.81	0.105	0.098
CI.5 ..	3.02	4.20	0.098	0.092
Silal ..	2.75	6.49	0.089	0.082
Nicrosilal ..	1.81	6.42	0.070	0.063

silicon, and showed fine flake graphite and ferrite on the edge, and fine graphite and pearlite inside, a second contained 4.20 per cent. silicon, and was wholly ferritic with fine graphite flakes, while the third, containing 2.81 per cent., had a structure intermediate between the other two. The remaining two special cast irons were the special heat-resisting cast irons, silal and nicrosilal, developed recently by the British Cast Iron Research Association. The former iron had a silicon content of 6.49 per cent. and a ferrite/fine-graphite structure, while the latter, containing 6.42 per cent. silicon, 18.65 per cent. nickel and 2.02 per cent. chromium, had an austenitic structure. Three other cast irons were also tested. These were irons of normal composition, but of varying prosphorus content, and their examination was undertaken to determine the influence of phosphorus on the heat-conducting property, as the influence of this element had not been investigated in any previous work.

A summary of the results from these various ferrous alloys showing their thermal conductivities at 100 and 400 deg. C. are given in Table II. The value for wrought iron of 0.175 is of interest, as it is higher than that generally accepted for ferrite, and it was obtained from a material which, besides containing ferrite, had a fair proportion of slag. Such a result suggests that the accepted value for ferrite is low, and that a better value might be that 0.187 obtained for pure iron by Benedicks.

The thermal conductivity values of the five carbon steels diminish as their carbon contents increase from 0.10 to 1.09. This is principally

due to the influence which carbon has on the structure in producing relative amounts of ferrite, pearlite and cementite. The solution of silicon in iron also lowers the thermal conductivity of ferrous alloys, and manganese is also known to have a lowering effect, which probably results from the manganese carbide formed having a very low heat-conducting value similar to cementite. The influence of those three elements on the thermal conductivity of iron is expressed by Masumoto in the following formula:—

$$K = 5.744 + 2.432\ C + 5.0871\ Si + 2.461\ Mn.$$

That this formula is substantially correct is shown when the values obtained for the five carbon steels are compared with the values calculated from their composition; these are found to be closely approximate.

The conductivity value of 0.120 obtained for the 0.92 per cent. carbon steel which had a structure consisting almost entirely of pearlite, with only traces of free cementite, is an approximation to the thermal conductivity value for pearlite, although such a value will be low, due to the presence of silicon and manganese and traces of free cementite, but it is in close agreement with the calculated value by Masumoto's

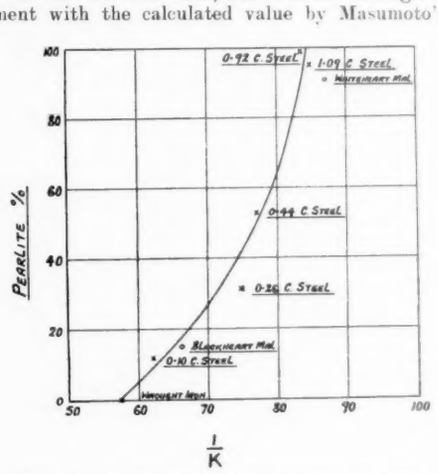


Fig. 1.—Influence of Structure on the Thermal Conductivity.

formula of 0.124 for pure iron containing 0.89 per cent. carbon.

The influence which structure has on the thermal conductivity of these ferrous alloys is shown in Fig. 1, where the thermal resistivity values of the wrought iron, the five carbon steels, and the malleable cast irons are plotted against their pearlite content and a smooth curve is obtained. The black-heart iron, containing 82.1 per cent. ferrite, 15.6 per cent. pearlite and 2.23 per cent. temper carbon, approximates to the 0.1 per cent. carbon steel, while the white-heart iron with 91.2 per cent. pearlite, 6.75 per cent. ferrite and 2.04 per cent. temper carbon lies in the region of the eutectoid steel, the slight variations which occur in these irons being probably due to the temper carbon and the higher silicon content.

The special cast irons tested cannot be considered in the same manner as the wrought iron, steels, and malleable cast irons owing to their composition and structural condition. The first three were specially prepared to obtain structures ranging from pearlite-fine graphite to ferrite-fine graphite, and in order to produce such structures the silicon content had to be varied. When their structural composition and those of four irons S1, S6, S8 and S9 containing 0.65, 1.24, 1.48 and 1.91 per cent. silicon, and tested previously, are plotted against their silicon contents, Fig. 2, the influence of silicon on the heat-conducting property of cast iron is apparent. As the silicon is increased from 0.65 to approximately 2.0 per cent., the decrease in the thermal conductivity is at first rapid and uniform, but becomes less rapid with silicon over 2 per cent. due probably to the changing structural condition from pearlite to ferrite, and the increasing proportion of ferrite with its higher thermal conductivity tending to counteract the effect of silicon in lowering the conductivity. The values obtained from the No. 5 iron and the silal show the direct influence of silicon, as both irons have similar structure, ferrite-fine graphite, but with 1.20 and 6.49 per cent. silicon, respectively, have thermal conductivities of 0.097 and 0.088.

The Nicrosilal iron has a similar silicon content to the silal iron, but the presence of 18.65 per cent. nickel, and 2.02 per cent. chromium renders the structure austenitic. Previous investigations have shown that while chromium raises the conductivity of cast iron to a slight extent, nickel lowers it considerably, and this is shown in the case of this austenitic iron where the thermal conductivity falls to 0.070.

The influence of phosphorus on the thermal conductivity of cast iron is to produce a slight decrease. This is seen by considering the values obtained from three irons of similar composition, but with phosphorus contents of 0.18, 0.59 and 0.95 per cent. Their respective conductivities at 100 deg. C. are 0.116, 0.115 and 0.111. It is difficult to say, however, whether the action of phosphorus is a direct one or due to segregation of the phosphide eutectic as the phosphorus content increases.

Electrical Resistivity.

The electrical property of a metal or alloy is usually defined in terms of its specific resistance rather than of its electrical conductivity, the specific resistance or electrical resistivity being the resistance of prism of a cubic centimetre. Conductivity is the reciprocal of the specific resistance and is measured in reciprocal ohms. In the case of pure metals, there is a simple relationship between the thermal conductivity and the electrical resistivity. This is known as the Lorenz's coefficient and is expressed as $K.\sigma = T.k$ where K is the thermal conductivity, σ the electrical resistivity, T the absolute temperature and k a constant. This has been applied by Schofield[4] to pure metals, and by Griffiths and Schofield[5] to alloys of copper and aluminium alloys. The former has shown that for certain metals it is constant up to 700 deg. C., and for aluminium there is a slight increase with temperature, while the latter investigators have shown that the constant does not vary greatly in an alloy from that of the metal which forms the principal constituent of the alloy.

Masumoto[6] has also shown that with steel the relationship holds with a considerable degree of accuracy, but in the case of cast iron, however, the relationship is not so clearly defined. The results of his investigations on white and grey cast irons were discussed in the previous article and indicated that the relationship held with a fair degree of accuracy for white cast iron, but where graphitisation occurred, either in white or grey iron, this relationship was altered, due to the different conducting powers of cementite, ferrite, and graphite.

Masumoto also showed that so far as composition was concerned, that in white iron, as the total carbon and silicon contents increased, the electrical resistivity increased, and in grey iron an increase occurred with increase in the silicon content, the carbon remaining constant. Somewhat similar results were obtained by Pinsl,[7] who found the electrical resistivity of cast iron to be 73 to 104 microhms per c.c. at ordinary temperature, and that a 1 per cent. increase in the silicon content increased the resistivity by 12 to 14 microhms, while a 1 per cent. increase in the graphite content, other things being equal, increased the resistivity by 10 to 12 microhms per c.c. Refining the graphite and the grain size diminished the resistivity, the minimum resistivity for a particular composition being obtained with a fine graphite-fine ferrite structure free from cementite. Increase in the combined carbon increased the electrical resistivity, but heat-treatment, which decomposed the combined carbon decreased the resistivity.

Electrical resistivity determinations were made by Pearce and Morgan[2] on the three ingot-mould irons examined for the Heterogeneity Committee of the Iron and Steel Institute. The results obtained are given in Table III. The test-pieces were selected from two places in the mould in all cases except No. 1. These results show that silicon and total carbon have a marked effect in increasing the resistivity. Combined carbon

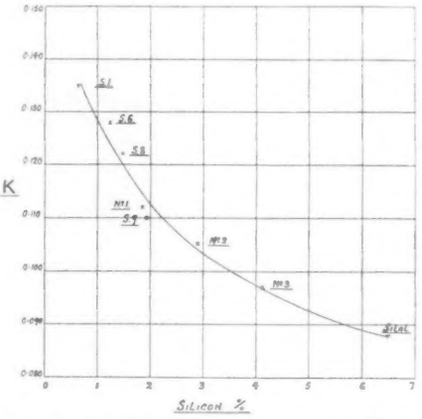


Fig. 2.—Influence of Silicon on the Heat-Conducting Properties of Cast Iron.

has also a marked effect, as is shown in bars from No. 3T, which contained respectively 0.61 and 0.83 per cent. combined carbon and have resistivities of 127.8 and 148.46 microhms per c.c. The same also applies to bars from No. 3B. The values obtained from the ingot moulds Nos. 1 and 2 after use are 101.2 and 131.34 microhms per c.c. These two values are rather at variance, as the former indicates a fall in the electrical resistivity following the annealing or heat-treatment effect produced on the mould by the liquid steel, whereas the latter shows an increase in the resistivity due to such treatment. With the exception of the latter value, the results obtained by Pearce and Morgan on those irons are in close agreement with the work of

Table III.—*Electrical Resistivities in Microhms per Cubic Centimetre at 16 deg. C. (Pearce and Morgan).*

Iron.	T.C.	C.C.	G.C.	Si.	Resistivity.
1 ..	3.77	0.82	2.95	1.81	117.80
2 ..	3.48	0.74	2.74	2.08	116.20
2 ..	3.49	0.79	2.70	2.05	111.03
3T ..	3.51	0.61	2.90	2.44	127.80
3T ..	3.43	0.83	2.60	2.46	148.46
3B ..	3.58	0.67	2.91	2.23	114.04
3B ..	3.57	0.77	2.80	2.20	125.87

Masumoto and Pinsl, so far as the influence of carbon, both total and combined, silicon and heat-treatment are concerned, with the electrical resistivity of cast iron.

Investigations by Norbury and Morgan[8] also show the effect of carbon and silicon on the electrical resistivity of grey cast iron. Determinations were made on a series of irons containing from 2 to 4 per cent. total carbon and 1 to 8 per cent. silicon. The results obtained show that an increase in the silicon or total carbon content has an increasingly great effect, the higher the silicon or total carbon content. In an iron containing 2.5 per cent. carbon, increasing the silicon from 3 to 6 per cent. increases the resistivity by about 75 microhms per c.c., and in an iron containing 4 per cent. carbon, increasing the silicon from 1 to 2 per cent. increases the resistivity by 50 microhms per c.c. Some of the irons had fine graphite structures and others coarse, but the results were not sufficiently systematic to reveal the effect of differences in graphite structure—as distinct from graphite content on the resistivity. Similarly, due to

variations in the combined carbon were not shown, but were estimated to be small.

In general, the work of recent investigations have been in agreement on the effect which composition and heat-treatment have on the electrical resistivity properties of grey cast iron. The results have also shown that there is a possibility of a relationship between the thermal conductivity and the electrical resistivity, as the conclusions are substantially what would be expected, if the Lorenz coefficient held for such alloys. If such a relationship could be established, it would be of great value in determining the thermal properties at high temperatures. The maximum temperature at which thermal conductivity determinations have been made is 425 deg. C. and up to this temperature there is a definite lowering of the conductivity with the temperature, but whether such a decrease continues cannot be surmised, as the presence of critical points and the structural changes, which result at the critical point, preclude the extrapolation of the thermal conductivity beyond 550 deg. C. Thermal conductivity determinations beyond 550 deg. C. are difficult, whereas electrical resistivity determinations are comparatively easy, and, if a definite relationship between tho two were established over a range up to 1,000 deg. C. it would allow of thermal values being calculated.

Specific Heat

Many determinations have been made of the specific heats of pure metals and of steel and other alloys over a wide range of temperature, but there is very little published data on the specific heat of cast irons. The earliest available data is that of Schmitz, who gave the specific heat of cast iron as 0.0890 for a mean temperature of −850 deg. C. and 0.119 for a mean temperature of 60 deg. C. More recent work is that of Umino,[9] published in 1926. This investigator determined the latent heat of fusion of several metals and their specific heats at high temperature. Among those was a cast iron containing 4.22 per cent. total carbon; 1.48 per cent. silicon; 0.73 per cent. manganese; 0.032 per cent. sulphur and 0.12 per cent. phosphorus. The mean and the true specific heats were given over a range of temperature from 100 to 1,350 deg. C. At 100 deg. the true specific heat was 0.131, and it increased to 0.202 at 1,000 deg. C. and to 0.215 at 1,350 deg. C.

The most recent work is that of Morawe,[10] who determined the mean specific heats or heat-capacity values for three cast irons over a range of temperature varying from 0 deg. to 1,350 deg. C. In an iron containing 3.71 per cent. total carbon, 1.50 per cent. silicon, 0.63 per cent. manganese, 0.069 per cent. sulphur and 0.147 per cent. phosphorus, the mean specific heats over the ranges 0 deg. to 200 deg. C., 0 deg. to 1,150 deg. C. and 0 deg. to 1,350 deg. C. were 0.110, 0.211 and 0.201 respectively. The values obtained in the other two irons were slightly lower, but whether this decrease was due to the increase in phosphorus content, in which respect the irons were different, or to slight increase in the silicon and manganese contents, there is not sufficient evidence to form a definite conclusion. The results in general, however, were lower than those obtained by Oberhoffer and Durrer for pure iron, and, taken in conjunction with the work of Honda,[11] who found that the specific heat of cast iron decreased as the combined carbon decomposed into graphite and ferrite, would appear to indicate that the general influence of silicon, manganese and phosphorus, and of heat-treatment, which tends to promote graphitisation, is to decrease the specific heat of cast iron.

Thermal Expansion

During the last few years a fair number of determinations have been made dealing with the thermal expansion of metals and alloys and include values for cast iron. Such values are usually determined over a range of temperature and are fairly accurate within limits, but show variations with the composition and structures of the iron, so that, in using any value, it is necessary to know the approximate composition of the cast iron. Such values are usually determined by some type of dilatometer or other, and from the dilatation-temperature curves obtained the coefficient of thermal expansion, the permanent expansion after heating, and the critical points on heating and cooling are determined.

Accurate determinations have shown the coefficient of thermal expansion of grey cast iron to vary from 1.2 to 1.5 × 10^{-5} over the range 0

Table IV.—*Coefficients of Thermal Expansion (Pearce and Morgan).*

Iron.	Expansion × 10^{-5}.
1	1.30
2	1.28
3T	1.31
3B	1.41

to 1,000 deg. C. The coefficient of expansion for the three ingot-mould irons already referred to were determined by Pearce and Morgan[2] and are given in Table IV. They show a slight variation depending on the composition. Investigation by Norbury and Morgan[3] on irons of the silal and nicrosilal type have shown that where the matrix is of a ferrite-fine graphite nature the average coefficient of expansion is about 1.4 × 10^{-5} per 1 deg. C., but where the matrix is austenitic in character and average value of 1.8 × 10^{-5} per cc. is obtained. It is pointed out that the fact that austenitic irons have a higher coefficient of expansion approaching to that of 2.35 × 10^{-5} for aluminium, makes them specially suitable for motor cylinders in which aluminium pistons are used, since the clearance is less affected by temperature changes.

Conclusions

The recent investigations which have been carried out on the thermal conductivities of ferrous alloys have shown that composition and structure exert an important influence on this property. Definite values have been obtained for the relative thermal conductivities of ferrite, pearlite and cementite of 0.187, 0.124 and 0.017 respectively. In steels the falling-off in thermal conductivity with increasing carbon content results from the influence which the carbon has on the structure in producing relative amounts of ferrite, pearlite and cementite. It is also possible to determine with close approximation the heat-conducting value of a steel from its composition by means of a formula. In malleable and other cast irons, composition and structure also exert an important influence, but owing to the complex nature of these alloys and the formation of free carbon, either as temper carbon or as fine or coarse flake graphite, the exact importance of either is not so easily defined. Silicon, which lowers the thermal conductivity of all iron alloys, causes a rapid falling-off in conductivity in cast iron, but with over 2 per cent. silicon this falling-off is reduced considerably owing to the formation of free ferrite. The influence of phosphorus is to produce a slight decrease in the thermal conductivity of grey cast iron. When nickel and chromium are added, however, in quantity and an austenitic structure is produced, the decrease in conductivity is most marked. The electrical resistivity of cast iron increases with an increase of the total carbon and silicon contents and heat-treatment which decomposes the combined carbon produces a diminution in the resistivity. The specific heat of cast iron varies with composition and temperature, and tends to diminish with graphitisation, and while there is little variation for thermal expansion in ordinary grey irons, there is a marked increase for this property in austenitic irons.

REFERENCES.

1 Proc. Inst. Brit. Foundrymen, 1930–31, Vol. 24, p. 290.
2 4th Report on the Heterogeneity of Steel Ingots.
3 Journ. Iron and Steel Inst., 1933, Vol. 78, p. 255.
4 Proc. Royal Soc., 1925, Vol. 107, p. 206.
5 Journ. Inst. of Metals, 1928, Vol. 39, p. 339.
6 Science Rep., Tohoku Imp. Univ., 1927, Vol. 16, p. 417.
7 Giesserei Zeitung, 1928, Vol. 25, p. 73.
8 Journ. Iron and Steel Inst., 1932, Vol. 75, p. 393.
9 Science Rep. Tohoku Imp. Univ., 1926, Vol. 15, p. 597.
10 "Die Giesserei," 1930, Vol. 17, p. 234.
11 Science Rep. Tohoku Imp. Univ., 1924, Vol. 12, p. 347.

Rainwater Goods and Baths

The Interdepartmental Committee, appointed to survey the prices of building materials, in its sixth interim report deals with the increase in the prices of rainwater and soil goods. At a conference with the British Ironfounders' Association prices were reviewed, and as a result the Committee takes no exception to the present prices fixed by the Association. Statements were made that no further increases of prices are anticipated and that ample reserve capacity exists for augmenting production.

The Bath Position

As the result of a conference with the British Bath Manufacturers' Association and the International Bath Association, the Committee was informed of the recent reorganisation of the industry and of the arrangements that had been made with Continental founders, whereby an opportunity had been afforded for competition on equal terms in the export market and a larger percentage of the trade had been secured for the home market. It was elicited that the experiments in the large-scale production of working-class-house type of bath of the porcelain vitreous-enamelled type were in progress. This and other factors precluded the Committee from making a final decision on the question of prices. No shortage and ample reserve capacity exists.

American Society for Testing Materials

CAST METALS AND ALLOYS (COPPER AND COPPER ALLOYS)

At the Washington meeting of sub-committee II on cast metals and alloys of the American Society for Testing Materials, Committee B-5 on copper and copper alloys, cast and wrought, held as part of A.S.T.M. Committee Week, March 5 to 9, it was decided to review all of the non-ferrous casting specifications and undertake necessary and desirable revisions. It is planned to emphasise the physical properties of these materials and to use the chemistry more as a guide—depending on the use and application of the material. The specifications for bronze bearing metals for turntables and movable railroad bridges (B 22-21) are being used more and more in highway bridge construction, and the committee is planning to initiate a review of the specifications, co-operatively with the American Railway Association and the American Association of State Highway Officials with the purpose of covering improved alloys for use in connection with bridges.

Chromium Estimation in Vanadium Steels

In the "Mitteilungen der Forschungs-Anstalt des Gutehoffnungshütte-Konzern," W. Erhard describes a simple method for estimating chromium in vanadium and molybdenum steels. The sample is dissolved in nitric acid and oxidised with K chlorate, treated with Pb acetate which precipitates lead chromate and lead molybdate, vanadic acid remaining in solution. The Cr is then estimated with iodine.

XUM

Design, Patternmaking and Moulding

COMPETITIVE METHODS OF PRODUCTION

By Matthew Russell

(*Concluded from page 269.*)

Large Pump Casing.—Being required for high efficiency, and definite streamlines being necessary, the drawing-office method as shown by Fig. 13 would involve a great amount of labour in the foundry, whereas the method illustrated in Fig. 13A eliminates this without sacrificing the streamline requirements.

Pattern-Plate Making

A pattern plate (Fig. 14) adopted at the author's works may be of interest, as it was evolved to ensure the use of half-pattern in general-jobbing foundries at very little cost. A flat board or plate is made for general-service work of this nature, with centre lines and jig-pinned holes. The sighthole blocks go the full depth of top part and are only 2 or 3 in. deep in drag. The

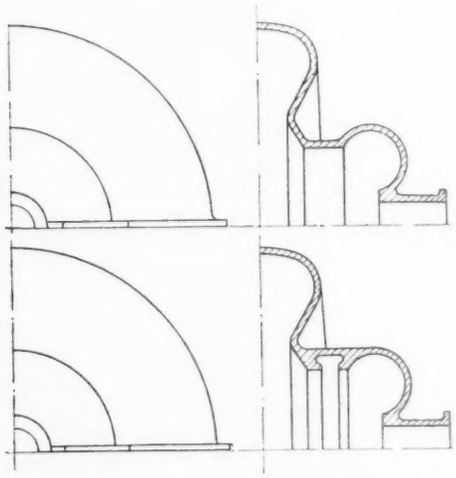


FIG. 13.—TOP AS DESIGNED, AND FIG. 13A (BOTTOM) AS MADE.

arrangement of the locating pins eliminates the absurd and antiquated method of "Sun about" when closing.

A typical example is shown in Fig. 15 in the use of service plate on work of a symmetrically designed nature, and can also be used with necessary alteration parts, as illustrated in this case by pipe with branches.

The half-pattern is mounted on service plate having the pins properly located. The drag half-box is then placed on it, with shallow sight-hole blocks and locating-pin blocks, ramming is then proceeded with and box turned over. The service plate is removed to enable the pattern to be drawn, and the service plate is then returned to former position and the pattern is mounted on it, also the deep sight-hole blocks and other halves of locating-pin blocks, when the top-part is put on and ramming proceeded with. This service plate is only necessary in foundries not having jig-pinned boxes; although the locating pins ensure a most accurate joint, it is essential to have provision made when assembling the mould. This is done by inserting checked sight-hole pins into drag half, the check giving a reasonable amount of clearance and ensures no damage being done during closing. It is also found by using locating pins that good joints are ensured, irrespective of poorly-pinned boxes.

There are many patternmaking and moulding labour-saving devices, which could be adopted without much, if any, increase in moulding costs, provided these two departments co-operate in the right spirit, and do not take the line of least resistance, as it is generally found, when anything new is put before the average foreman moulder, and it is said that it cannot be done with existing plant. Neither can it, as long as he and his tribe are allowed to hold the field. This was the attitude assumed on the service plate mentioned, but it was made and sent to foundry, and is now used without any necessity to scrap the existing plant. Unless those who are engaged in the manufacture of castings and making of patterns find more ingenious and cheaper methods and have them universally recognised and adopted, it will be found that weldings will be often substituted. One firm which had a turnover of 300 tons of castings per month have reduced this by 100 tons in favour of fabricated design. This, to the author's mind, is largely brought about by the inexperience of the designers in regard to the possibilities of patternshop and foundry practice, and also by want of initiative on the part of foundry and patternshop managers and foremen in not taking a hand in design, as the makers of weldings are doing at the moment.

Engineers would find a great saving by having a larger proportion of responsible men in their design departments with a knowledge of patternmaking and moulding. These men would have sufficient experience to enable them to cut down costs by making designs which would be practical and not unnecessarily elaborate. By so doing they would probably find the saving in cost far beyond their expectations. It will be agreed that in many cases the want of linking up these operations, as is nearly always done in machine-shop management, has proved more costly than is generally realised.

DISCUSSION

The CHAIRMAN said that Mr. Russell insisted he never knew of one who was qualified in all branches of foundry work. He personally had one man who was a patternmaker, an engineer and lastly a moulder. He had a feeling that he ought as an engineer to back up the method of fabrication. In regard to castings for one-off he often implored the patternshop to make the pattern just good enough for one-off, but he always got the same old thing nicely sandpapered, varnished, etc., as if it was for 100-off.

MR. JOHN SIMPSON (Brown Bros.) said he wondered why as a patternmaker Mr. Russell had such a bad impression of the moulder; probably for want of sufficient acquaintance with him. There was no foundry at the firm with which Mr. Russell was connected, and he thought that if

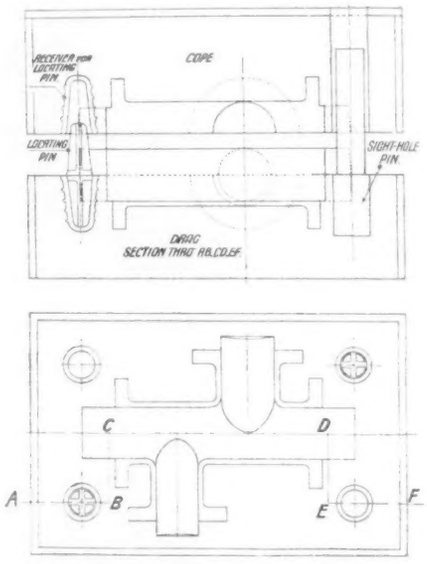


FIG. 14.—PATTERN PLATE ELIMINATING "SUN ABOUT" METHOD.

he had a little more personal contact with moulders in two or three foundries he would alter his views about them.

MR. A. BRUCE (Mackenzie & Moncur) said that in regard to the use of cheap patterns they usually made a good job of those they made themselves, but patterns which came in from outside were often made on piecework or bonus rates and often after they had made nine or ten castings off them they were ruined or required to go into the patternshop for repairs, when it was found that they were just glued up or had an odd screw here and there. In regard to the service plate which Mr. Russell had shown them, he thought that the idea was very good and the guide pins at the corners quite good, but one thing about it was Mr. Russell did not finish it as he would do. Mr. Russell put on a ribbed pattern which he stated was made to help the moulder, but it would have been better to make it solid as it would have helped the moulder much more. All the slots in the pattern shown would require to be made up with sand which

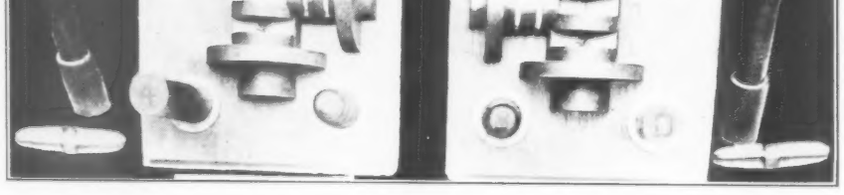


FIG. 15.—PATTERN PLATE FOR SYMMETRICAL WORK.

would be avoided with a solid pattern. He considered that the use of the old sun-about method was due to the pins and holes wearing. If the boxes were made with a bigger snug it would be better. Boxes are as a rule kept outside in the yard, and in consequence rust so that the hole in the snug gets bigger if they are not greased before being put out. They had boxes made for mass-production jobs so that no sun-about was necessary in closing, because the pins and holes were a good fit. These boxes after being outside could not be separated, so they always greased them.

In regard to the half-coupling mentioned by Mr. Russell, he had had experience of that type of casting. They made a chill for the holes with a screwing arrangement, so that they could be drawn out, with the result that the hole was as clean as a bored hole.

Mr. Michie (Harland Engineering Company, Alloa) said Mr. Russell had always had a flair for rough patterns. He thought the real trouble was with the suppliers, because what was a good pattern for one foundry was useless to another foundry. He thought the buyers should stick to one foundry for the castings if the difficulties had been overcome there. In regard to the impeller, he had difficulty in knowing how Mr. Russell removed the pattern. He had talked about the star core, but, personally, he would not use it. The whole secret of a good impeller casting was obtaining it with a clean water way. Oil sands and split cores made things much easier. Gating and feeding were the secrets of success, and he would cast it down with the ring down and the boss fed on the underside. He had been very interested in the Paper, and was glad to have had an opportunity of speaking on it.

Mr. A. D. Kirby said that the part of the Paper which really interested him was the part referring to the impeller casting where Mr. Russell stated that he used a pencil strainer. From the slide which was shown he had thought that the idea of the whistlers was to take the air away, but, seeing the size of the strainer core made him wonder why Mr. Russell used the whistlers, and he would like to hear the author's reason. Mr. Russell had made no reference to thick and thin sections adjoining, and as a steelfounder he would have liked to have heard something on that aspect of the subject.

Mr. J. Currie (Branch-President) said it seemed to him that the idea was for the pattern to be made in the shop and the moulder had to do as he was told. Coreboxes were only to be used when Mr. Russell said so. He was afraid that they would run against a snag when patterns were brought in from outside. Mr. Russell had referred to the difficulty of obtaining the same metal in two castings, and he suggested that the difficulty would be overcome by casting the two together.

Mr. A. Bruce (Mackenzie & Moncur) said that in regard to casting two pieces together he was not altogether in favour of the arrangement; he would cast the pieces separately out of the same ladle of metal. Mr. Russell had referred to the moulder and his analysis and did not appear to believe much in it.

AUTHOR'S REPLY

Mr. M. Russell (Drysdale & Company), in reply, said that Mr. Simpson had asked why he was so down on the moulder, but having no foundry in the works with which he was connected he got to know the moulder's ways, and it was the fact that the buyer had the pull over the foundry. Mr. Bruce had referred to the fact that outside patterns were received which were not up to standard. His firm also obtained patterns from outside firms; they bought a lot of patterns in, but in giving the order they gave the patternmaker a specification giving the thickness of the wood, etc., which was to be used. In regard to not being able to secure the co-operation of the moulder, if he asked a moulder for his views and showed him the drawings he was told either that it was no good or he had no plant to do the job that way. Mr. Bruce had suggested casting the two pieces together or to cast from two separate patterns from the same ladle of metal so as to obtain them both the same. The moulders all said that, but a moulder would cast anything out of one ladle. He had recently been in a foundry where they were casting some plant for him of a special metal. He was told that 15 cwts. of special metal was melted, but on reckoning up the number of castings and the weight of them he found that more than 25 cwts. of castings were obtained from the 15 cwts. of special metal. If he had to depend on the men casting a number of boxes out of the same ladle he could not have much confidence in them. In other cases he had known of the metal being considered too hot for the casting, and the moulder starts to cool it by dropping in cold scrap. The scrap is the nearest thing that can be lifted, and usually common material is dumped into special metal, which results in the analysis being altered. Regarding skeleton patterns, he would be the last to varnish them or even to plane them. What he had on the table was only a model. Mr. Michie had said that he had always been an advocate of cheap patterns, but whilst that was so he could make a good one when necessary. He did not believe in costly and elaborate patterns for a one-off job. Regarding the impeller, Mr. Michie had said that he was in favour of segmental coreboxes, but in his view that led to trouble, as there was a lot of distortion in the core segments in handling and drying, and when the moulder came to get in the last segment he would say to himself "I have to get this in somehow," so he started to rub off or chip. The result was great irregularity in the finished castings. It had been suggested that the impeller should be cast the other way up, but he had tried every conceivable way and found the best results from adopting the method which he had described. There was not so much difficulty with straight alloys such as gunmetal, but with fancy alloys there was great difficulty.

The reason for using the whistlers and the star runner was because they got so much trouble from drawing when the job was cast in special alloys. In ordinary gun-metal they could make a clearance on the core and allow the print to come up so as to get the necessary rest, so with ordinary materials the whistlers could be discarded.

Mr. Currie had also referred to making two castings in one and to the feeding. His method had the advantage that it allowed a half-replace to be made easily, whereas the other method meant the making of the whole for a replace. If the necessary feeding could be made then it was equally easy either way.

The Chairman said that the lecture had been exceedingly interesting and an incentive to all to take care in giving orders and to see that they get what they order. It was seldom that they were so fortunate as to obtain a lecturer who could bring a motor lorry full of exhibits and specimens. He, on behalf of the Branch, tendered to Mr. Russell their cordial thanks for his Paper and the immense amount of trouble to which he had gone to make it interesting and instructive.

Foundry Developments

Allied Ironfounders, Limited, announce that, as part of the policy of reorganisation, it has been arranged that Messrs. McDowall, Steven & Company, Limited, should take over the Castlelaurie works of the Falkirk Iron Company, Limited, a company in the allied group. These works have for a time been closed down for the purpose of installing new plant; preliminary tests have been made preparatory to the new plant being brought into full production at an early date.

Institute Elects New Members

At a meeting of the General Council of the Institute of British Foundrymen, held at the Midland Hotel, Derby, on April 21, 1934, the following were elected to the various grades of membership.

As Members.

R. H. Myers, metallurgist, National Federation of Iron and Steel Manufacturers; H. D. Bennie, chief chemist, J. Dougall & Sons, Bonnybridge; S. Bethell, metallurgist, Armstrong, Whitworth, Limited, Gateshead; C. H. Dicken, manager, E. Preston, Limited, Kidderminster; — Fazakerley, foundry manager, Burn & Company, Howrah, India; E. H. Jones, engineer, chairman, International Meehanite Metal Company, Limited; F. W. Neville, B.Sc., technical engineer, J. W. Jackman & Company, Manchester; S. Owen, works manager, Widnes Foundry, Limited; D. J. Parsons, Stanton Ironworks Company, Limited; W. Pollard, B.Sc., works manager, J. Pollard, Limited, Burnley; M. D. Thompson, director, Rapid Magnetting Machine Company, Birmingham; C. B. Brown, foundry manager, Chas. Perks, Willenhall; R. H. C. Weeks, foundry manager, British Northrop Loom Company; L. H. Hines, representative for Foundry Equipment; E. S. Lord, core oil manufacturer; A. Prescott, representative, Universal Grinding Wheel Company, Stafford.

As Associate Members.

A. Bayley, foreman, Iron Foundry, L.M.S. Works, Crewe; W. Brown, foundry foreman, Mather & Platt, Park Works, Manchester; C. W. Clarke, moulder; S. H. Cooke, ironfounder, St. Ives, Leicester; F. C. Cotten, assistant foreman, J. Stone & Company; N. Denison, under foreman, Platt Bros., Oldham; J. Dixon, foundry foreman, G. Salter & Company, West Bromwich; E. B. Ellis, analytical chemist, Sir W. G. Armstrong, Whitworth; H. B. Farmer, foundry manager, Rice & Company, Northampton; R. W. Greenhalgh, patternmaker, Walmsleys, Limited, Bury; J. Hetherington, metallurgist, Armstrong, Whitworth, Limited; R. Horn, estimate clerk, Burnbank Foundry, Falkirk; E. Jackson, iron moulder, J. & E. Arnfields, New Mills; H. S. Joynes, iron moulder, Premier Gas & Oil Engine Company; H. A. Kemp, brass foundry foreman, Crofts Engineers, Limited, Thornbury; J. P. Laird, range fitter, Smith & Wellstood, Limited; C. G. Masson, metallurgist chemist, Sir W. G. Armstrong, Whitworth & Company; C. G. Mackenzie, B.Sc., engineer and metallurgical student, Hopkinsons, Limited, Birkby; W. Plant, metallurgist, Constantine Technical College; E. S. Renshaw, foundry metallurgist, Ford Motor Company; P. Scholes, assistant foreman moulder, W. Dickenson & Sons, Blackburn; G. O. Stanley, foundry chemist and metallurgist, Cochrane Foundry, Limited; W. Turnbull, assistant metallurgist chemist, Sir W. G. Armstrong, Whitworth & Company; S. H. Ward, machine moulder, Ford Motor Company; J. M. Wright, clerk, Burnbank Foundry Company, Falkirk; J. Yates, jun., patternmaker, Walmsleys (Bury), Limited.

As Associates.

A. McI. Scott, clerk, Mitchell, Russell & Company, Limited, Chattan Foundry, Bonnybridge; A. L. Cheeseman, moulder, Ashmore, Benson, Pease & Company; H. R. Darcy, engineering apprentice, L.M.S. Railway, Glasgow; D. Malone, iron moulder, Howard & Bullough, Accrington.

As a result of the steadily increasing demand for East Coast hematite pig-iron, Messrs. Pease & Partners, Limited, have found it necessary to light up another blast furnace at their Normanby Ironworks. There are already two furnaces operating at these works and the third unit now to be started will increase to 29 the number at work on the North-East Coast.

XUM

The Steel Castings Report

DISCUSSION IN GLASGOW

A special joint meeting of the Scottish Branch of the Institute of British Foundrymen with the West of Scotland Iron and Steel Institute and the Institution of Mechanical Engineers (Glasgow and West of Scotland Section) was held in the Royal Technical College, Glasgow, on March 1, for the purpose of discussing the first report of the Steel Castings Research Committee.

Mr. A. Lindsay Forster (chairman, Scottish Branch, the Institution of Mechanical Engineers) occupied the chair, and he was accompanied to the platform by Mr. W. H. Cathcart (Vice-President, West of Scotland Iron and Steel Institute) and Mr. John Currie (President, Scottish Branch, the Institute of British Foundrymen).

The CHAIRMAN said that the value of such joint meetings as these could not be over-estimated. They illustrated the possibilities of co-operation in the proceedings of their respective societies. His experience of steel castings was that these had always been a fruitful source of discussion. All sorts of things had been said regarding steel castings and their defects, and it was often very difficult to get anybody to apportion the blame for some of the outstanding defects. On this occasion they were resolving themselves into a joint meeting to discuss this subject, and they represented three particular aspects of the subject of castings—the designer, the engineer and the user; the metallurgist; and the foundryman, and if these three amongst them could not do justice to the subject of this Report then he would be very much surprised. They had with them Dr. Greaves, who had very kindly come from Woolwich to present the subject of this Paper to them.

MR. W. H. CATHCART (Vice-President, West of Scotland Iron and Steel Institute) said that, as they all knew, they had expected that, along with Mr. Currie, Dr. McCance would have accompanied the chairman (Mr. Lindsay Forster) to the platform. Owing, however, to his having, somewhat hurriedly, to proceed to the Continent on business, Dr. McCance had not been able to be present, and he (Mr. Cathcart) had been asked to take his place.

Introduction of Report

In introducing the First Report of the Steel Castings Research Committee, being a Committee of the Iron and Steel Industrial Research Council, DR. R. H. GREAVES, of the Research Department, Woolwich (a member of the Research Committee), said that when he met the members of the Steel Castings Committee last month and told them of this forthcoming discussion they were very gratified because they set great value on the outcome of this evening's discussion. It is very appropriate that it should take place in Glasgow. Some years ago there was a similar discussion on steel castings. At that time the staff at Woolwich were working on steel castings for the Admiralty, and in the course of that work it had enlisted the sympathy of a number of experts in steel-foundry work. Subsequently to that discussion these gentlemen were formed into a Committee of the Department of Scientific and Industrial Research, which has now become a Committee of the National Federation of Iron and Steel Manufacturers. The Steel Castings Research Committee originated in that way, and, although it has only published one report, he hoped it was the beginning of useful work.

The Committee started by examining some typical steel castings varying from about 1½ cwts. to 4 tons in weight, made in the course of ordinary manufacture, in order to throw light on the characteristics and relative importance of various defects. This led to the view that the most widespread and commonly-occurring defects—and those most difficult to overcome—were contraction cavities and cracks. Other defects, of course, may occur, but are much more readily prevented. He then illustrated a few features of this preliminary work.

The first slide, which had been reproduced, was a lengthy abstract published in THE FOUNDRY TRADE JOURNAL issue of June 1, 1933, showed a radiograph of a valve casting which was apparently sound inside and outside, but actually contained the cavity shown, in the wall. This cavity when cut open was quite bright and showed a dendritic surface. More commonly, access of air to cavities has made them dull and oxidised, though their surface was seldom decarburised unless they have been subject to the action of steam derived from the mould. The macro-structure sometimes shows a useful indication of the direction of flow of metal before solidification. When the metal was filling a section of the casting, solidification takes place from the sides, and as the metal in the centre continues to move forward, these V-segregates are formed. They generally mean that on the broad side of the V there is insufficient feeding due to inadequate heads or a too restricted area of gates, while on the side to which the V is pointing one must look out for cavities. A typical radiograph showed cracks in a region which showed leakage in the walls of a hydraulic cylinder. A section revealed that the cracks were associated with the columnar dendrites on the outside of the wall.

In some cases, by etching, it is found that the cracks run through a region of high-phosphorus content. If the steel be broken apart, the outline of the dendritic structure through which the crack was formed, remains. The cracks were produced at high temperatures while the dendritic filling was very weak. Brackets and chills may be used to prevent cracking, but there was often a tendency to lead to a displacement and not an elimination of the defective regions.

In order to study these defects and their remedies a programme was drawn up for the manufacture of a particular casting under carefully-controlled conditions and for a comparative examination of the products. The casting selected weighed 2½ cwts.; it was a flanged hollow cylinder with three branches on one side and two on another at right angles to the other branches.

In the first place the design was submitted to a number of practical steel-foundry managers of different works for their opinion as to how it should be made, and the divergence of opinion expressed was very instructive.

One works maintained that the most economical method of making the casting was to cast solid with suitable cores for the branches and subsequently to bore out. Another that it should be made in two pieces separated at this flange. Of those willing to attempt the casting as it stood, five said it should be cast horizontally with the three or two branch side up; one that it should be cast horizontally with the two branch side down; one that it should be cast vertically with the end containing the large flange down. There was a similar divergence of opinion as to the size and distribution of the heads, as to where the casting should be run, and with regard to minor modifications.

One casting which turned out to be very unsound, full of cavities but free from cracks, formed the subject of the first folding plate of pictures in connection with the Appendix of the Report on radiological examination. Another casting which was perfectly free from cavities throughout was ruined by a circumferential crack at the heavy flange. Cavities when present were either bright or dull, but were never decarburised. The V-segregates were observed in the walls of some of the castings, and were an indication of inefficient feeding, and were often associated with cavities situated beyond the point of the V.

The experience with 16 castings made to this design directed attention particularly to the importance of correct choice of the position of the casting in the mould and of the runner, the effect of variation in the weight, area and spacing of the heads, the rate of filling the mould and the casting temperature employed.

The best position in the mould was found to be horizontal with the 3 branch side up, the proportion of heads 40 per cent. of the metal cast, properly spaced and with a certain minimum total area of gates. The best position of the runner was probably at the base of an end flange (certainly not in the thick flange), but there was some evidence to show that the best position of all was in the wall between the two flanges. It is an interesting fact that the results point to the desirability of filling the mould as rapidly as possible, if necessary continuing to feed the heads as solidification occurs. A higher casting temperature did not compensate for a reduced rate of pouring.

Now, much of this applied only to the design under consideration, and every new design of casting remains to some degree an individual problem, but it was hoped that the report would direct attention to three types of difficulty encountered in the manufacture of steel castings.

First, the natural difficulties depended on the physical properties of fluid and solid steel. These properties must, of course, be accepted, and utilised to the best advantage (or to the minimum disadvantage) of the finished casting. This immediately introduced questions of design. So much had been said on this subject that it was not proposed to say anything further at present except that co-operation between designer and founder was an essential step in further progress, and at the same time one of the most difficult to organise.

And then, finally, there were the economic difficulties. If the very high standard demanded was to be maintained it must be recognised that this standard involves heavy outlay. The supply of steel castings at prices which tempt the steel-founder to avoid loss by undue economy in the provision of the necessary safeguards is bound to lead to an inferior product.

A Report of this kind necessarily laid emphasis on the defects associated with castings. It must always be remembered that the great majority of steel castings were quite suitable for the job for which they are made, and that it is in those specialised castings and the small minority of high-duty material that defects are most prominent. The fact that they were prominent in this Report should not be taken as in any way an indication of the general character of all steel castings. A Report of this kind was necessarily devoted mainly to material which is defective, since material which had proved to be good has not the same interest for investigatory purposes.

Contraction Difficulties

MR. A. CAMPION said that in reading through the report he had observed a confirmation of the fact that the major part of the steelfounder's difficulty is due to the large contraction which the metal undergoes in cooling from the liquid to the solid state, and also the fact that steel immediately after solidification has practically no strength. He recalled the words of a very shrewd old founder when he was beginning to take an interest in foundry work more than 30 years ago that "If you wish to be successful in foundry work you must learn all about venting, all about gating and all about feeding. That is the first, the second and the last thing which you must learn." He thought the report bore out very fully the old founder's dictum. The matter of gating and feeding had been men-

tioned very frequently, and in fact variations in these constituted the main differences in the various methods of casting that had been tried or suggested. The matter of venting and permeability of the mould did not appear to have been given the attention which he thought it merited. He wished to suggest, and in view of the fact that this was a first report, he assumed that Dr. Greaves and his committee were inviting suggestions for future work, that some attention should be devoted to the characteristics and properties of the materials of which the moulds are composed. A good deal of work had already been carried out in this direction by the Technical Committee of the Institute of British Foundrymen. The sub-committee on sands and refractories had been working for some time now. They had arrived at a suitable standard-testing procedure and were now preparing a list of properties of the various moulding materials with a view of tabulating the properties required in sands and moulding materials for various types of castings. He thought that if Dr. Greaves and his committee considered that they could obtain assistance from the Institute of British Foundrymen's Committee it would be gladly given. He had no mandate to speak officially, but as a member of that committee he felt sure that they would be only too pleased to collaborate with Dr. Greaves. He mentioned this aspect of the problem because he felt that there was a great deal of work to be done on it in its relation to the production of difficult and intricate castings. This was perhaps specially the case in regard to cores, because many troubles arose from the fact that the cores were lacking in collapsibility. The result was hot tears and cracks due to the strain on the metal when in its weakest condition.

The Hydraulic Cylinder

He did not propose to discuss the report in detail, but he wished to refer to the hydraulic cylinder which was cast from a main downgate with a number of side feeders. That seemed to him a most undesirable method to adopt as there would almost certainly be some lapping of the metal and a resulting pull on the steel when it was in the condition in which it was least able to withstand it. Dr. Greaves had referred to the desirability of filling the mould as quickly as possible, and he thought that he was right. His own view was that it was essential to pour the metal at the quickest possible rate so as to get the mould flooded and filled in the shortest space of time. He thought that the mould should be filled quickly until the metal reached the feeding head and then to pour hot metal into the riser. That produced a swing or oscillation of the metal in the mould which tended to equalise the temperature and also to free gases. In this way solidity and soundness was obtained. It was also necessary to be very careful with the teeming of the metal; he had frequently seen castings spoilt through a dripping stopper or splashing allowing a little metal to fall down the gate which caused shots to be formed and these shots never seemed to melt again. The pouring should be done so as to allow the gate to be completely filled with metal, otherwise the thin stream of metal acted as a sprengel pump and sucked in a certain amount of air which caused sponginess and holes in the casting. The use of plugged gates or strainer cores was to be recommended. The difficulty was that entrapped gas or shot always seemed to lodge at the most undesirable positions. The number and position of the gates and risers had been discussed in the report, but nothing had been said about the size and shape of them, but it was an important matter and required careful consideration. He had experienced cases where it was impossible to produce satisfactory castings when round gates and runners were employed, but with a rectangular shape the castings turned out good. Probably such details would be dealt with in future reports which he thought all would look forward to with great interest.

Influence of Chemical Composition

Mr. MacConnachie thought the Report certainly gave a useful line on the best quality of metal for ordinary castings, and spoke as one having been associated with steel for castings since 1888. If they looked at this particular casting as shown on the board they found from table that out of all the castings there referred to only three were cast without cracks. One of the three, No. 7, was cast from acid open-hearth steel, and if they looked at that they found that it contained carbon 0.31, silicon 0.34, manganese under 1 per cent. and sulphur and phosphorus very low, and that the casting had no cracks in it and was normally sound. In a long experience he found that that particular metal was a metal which gave no exceptional trouble in the foundry. Taking an ordinary casting, they found that there was less trouble with high carbon, relatively low silicon, and manganese not quite so high. If they looked at the physical test they would find that this was very good.

A rather singular thing, which perhaps Dr. Greaves could explain, was that the elongation on that casting unannealed was 21 per cent., while annealed it was exactly the same. That seemed to him to be rather strange. With regard to the castings no particulars were given about bends, except that each casting would have bent comfortably to 90 deg. He should say that here they had demonstrated a type of metal relatively pure which gave a sound casting, with no great trouble at all, the one necessity being that the carbon should be kept up. If they looked at the other two castings, each described as free from cracks, they found that they had also relatively high carbon, 0.26 per cent., so that here again they had the clear indication that the way to minimise cracking trouble was to keep the carbon up, which of course was a matter of common sense, but they should avoid segregation by keeping out silicon as much as possible.

They should not allow quite so much manganese, and, of course, must keep sulphur and phosphorus down. He might refer to some data quoted by Dr. McCance from a foreign source some time ago, which proved that contraction was lessened as the carbon increased while it increased with greater content of silicon and manganese. He would repeat, this gave them a clear indication as to what kind of metal was the best to aim at in general foundry work for steel castings. The Committee had paid some attention to the ratio of metal in a casting to the metal required to produce a casting.

Generally speaking, they would consider that the extra metal was feeding metal in the heads, but as a result of some observations long ago it seemed there was a bigger effect than that. Supposing they had not a feeder head on at all, but simply run some metal through the mould, he felt sure that in many cases a casting would be saved if the man pouring just run some metal through, not necessarily to feed, but just to flush out in a way. By this means any gases forming would be expelled. He repeated that he thought they had a clear indication that the best metal for all-round foundry work was that with about 0.30 per cent. carbon, 0.2 to 0.3 per cent. silicon, about 0.60 per cent. manganese, and the sulphur and phosphorus under 0.04 per cent. One point which he might refer to was rather curious. Some of the Committee had commented on certain decarburised cavities. It occurred to him, however, that instead of those being decarburised cavities another explanation was that they came from precipitated metal from slag globules, containing oxide of iron. They got the iron reduced, and the metal, of course, attached itself in the cavity. It might not be decarburised metal, but iron.

Contraction Cavities

It was a very pleasant thing indeed that foundrymen fairly often found no cavities where in the ordinary course of things they would look for them. It happened quite often that when they expected to find a cavity if they cut it up, they found it was solid steel. He might be springing something new, but he thought this was due to a peculiarity not often mentioned, namely, the effect of the expansion of steel at the moment of solidification. To begin with, the mould was rigid, and the metal on solidifying had a tendency to expand inwards, thereby lessening the capacity for fluid metal and sometimes driving or pressing the still fluid metal downwards into heavier section. They could see that expansion at the moment of solidification might act in this way, and from that they got a line as to why and how it gave the pleasant experience of no shrinkage cavity where they would expect it.

On the question of safe chilling, it might be possible to see a volatile chill, that is where the cooling effect is produced by the heat taken up on vaporising such a thing as tar. That might help, but they must make sure that the material coated has the highest degree of permeability and, of course, permeability they must have, in addition to uniformity of grain, comparatively large grains, or very loose packing. That was just an idea which had occurred to him from observation through a long experience.

Difficulties of Correlation

Mr. Knox said he had looked up the records of some work they had done in connection with steel castings. They had had an investigation some years ago, and it might be of interest to them to mention some of the facts that he had picked out. They had two electric steel furnaces in their works, one of a capacity of 25 cwts. and the other of a capacity of 20 cwts., and during the time of that investigation it seemed to be proved that the quality of castings was not dependent on the state of the furnace linings. Another fact which came to light was that variations in the casting temperatures, within limits, did not seem to affect the quality of the castings, or the proportion of good or bad castings. Another point was that the number of defective castings in any heat, and the time taken to melt the steel, was not related.

There was no need to set up a standard of 100 per cent. immunity from defects in every respect, so long as the casting was adequate for the job. He wished that many Inspectors would take that to heart. Further points mentioned in the Report were with respect to contraction, cavities, blow-holes, porosity, sand inclusions and quality of the steel. As regards mechanical tests, these usually gave quite satisfactory results.

It was emphasised in the Report that well-designed heads were necessary, and as regards weight of metal to the weight of the finished casting, the Report stated that a proportion of heads of 44 per cent. by weight to the total metal cast produced reasonably sound castings. In the works where he was employed they run about 50 per cent. excess weight of the metal to weight of the finished casting. He quite agreed with what was said in the Report about competition being a source of causing castings not to turn out as well as they might do, but this was rather a matter affecting the steel foundry people. He thought the Research Report brought home to engineers and steel foundrymen generally the fact that all these steel-casting problems bristled with difficulties, and that the people who turned out the castings, namely, the foundrymen, were deserving of much sympathy, because steel-casting defects seemed to come in cycles. Some weeks gave reports that the castings were up to standard, and during other weeks the castings had many defects, but he thought that in the Report there was some consolation for the steel foundryman, and that was that castings seemed to be a bit of a lottery.

(To be concluded)

XUM

Reactions Between Pig-Irons and their Slags

The usual practice in blast-furnace operation is to take gas, pig-iron and slag samples from different points in the furnace and to deduce the conditions and progress of the smelting process from the analytical data thus obtained. The last sample before tapping is taken at the slag notch, although the important reactions between the molten iron and slag below the notch cannot be directly observed. Even if a representative sample were taken from the well, comparatively little valuable data would be obtained, as, owing to continual trickling-down of iron and slag, no stable equilibrium is ever reached. To obtain information of the reactions between iron and slag, the blast must be shut off for a short time, and iron and slag samples taken at regular intervals.

In comprehensive experiments made by W. Dinkler, and described in a recent issue of the "Mitteilungen aus d. Kaiser-Wilhelm-Institut für Eisenforschung," samples of pig-iron from different furnaces were melted with their corresponding slags under varying conditions in a CO atmosphere, subsequent analyses being employed to draw conclusions regarding the mechanism of the reactions in the blast furnace itself. In each case the pig-iron and its slag were melted together, the time of reaction, the temperature and the basicity of the slags being varied.

Under these conditions, about 60 to 80 per cent. of the iron oxide in the slag were very quickly reduced in a carbon crucible, to be followed by Mn and Si reduction at a much slower rate. The Mn and Si reduction is the more complete the longer the duration of the reaction and the higher the temperature, which appears to prove that these reactions cannot take place in the blast furnace owing to the high ferrous-oxide content of ordinary blast-furnace slag. With an acid slag, much silica and no Mn oxide are reduced, the reverse being observed with a basic slag. The transition from acid to basic character occurred at a basic value of 54 to 56, this value being given by the expression $\frac{CaO \cdot 100}{CaO + SiO_2}$, the lime, combined with sulphur, being neglected. Comparison of the calculated equilibrium constants for the manganese reaction with previous values showed that for basic iron with low Si the results after a short reaction period are about the same as in steel manufacture, while with high Si contents of the iron and low oxide values for the slags the equilibrium constant is lower.

German Foundrymen's Technical Association

The annual meeting of the German Foundrymen's Technical Association, which is to be held at Berlin on May 26 and 27, will celebrate the 25th anniversary of the founding of the Association. The technical Papers to be read include the following:—"German Malleable Iron as a Structural Material in Machines and Plant," by Dr. K. Roesch, Remscheid; "Cast-Iron Mixtures and Properties," by Dr. Väth, Munich; "The Fatigue Strength of Cast Iron and Its Relationship to Structure and Surface Characteristics," by Dr. C. Pfannenschmidt, Cologne; and "Foundry Competition is Necessary," by Dr. H. Antoine, Berlin. The principal address will be delivered by Prof. Dr. A. Friedrich, of Clausthal, who will speak on "Honour and Loyalty as a Basis of German Labour." In connection with the anniversary celebrations, the Association have been invited to a reception by the City of Berlin at the Berlin City Hall on May 26. Further details of the meeting, etc., may be obtained from the Verein deutscher Giessereifachleute, Friedrichstrasse 100, Berlin, N.W.7.

To Present Exchange Paper

MR. C. M. SAEGER, JUNR.

Mr. Charles Marshall Saeger, junr., the author of the 1934 Exchange Paper for the Institute of British Foundrymen, is a physicist of the United States Bureau of Standards and chief of the Experimental Foundry Section of the Division of Metallurgy of that Bureau.

Mr. Saeger was born at Allentown, Pennsylvania in 1893 and received both his general education and his earlier special technical training in the schools of that state. He was general foreman of the lithopone and sulphuric-acid plant of the New Jersey Zinc Company from 1913 to 1917. During the war he was attached first to the 311th Field Artillery, 42nd Division, and later was detailed to the 1st Research Bat-

Mr. C. M. Saeger, Junr.

talion of the Chemical Warfare Service, and stationed at the United States Bureau of Standards for metallurgical work.

Following the close of the war, Mr. Saeger became a member of the metallurgical staff of the Bureau of Standards and for the past 12 years has been in charge of the foundry section of that Bureau. During this time his major interests have been in problems connected with the control and testing of moulding sands, the running or casting qualities of foundry metals, special rubber core binders and moulding-sand facings, the volume changes in metals during casting, the spraying of metals, and the influence of various factors of foundry practice and chemical composition on the properties of cast brass.

Mr. Saeger is a member of the American Foundrymen's Association and the American Society for Metals; chairman of the Committee on Foundry Apparatus and Supplies of the Federal Specifications Board; member of the American Foundrymen's Association Committees on Grey-Iron Castings and on Fluidity Testing of the Grey-Iron Division; of the Advisory Committee of the Non-Ferrous Division; a member of the Moulding-Sand Research Committee since its formation over 12 years ago; member of the Sub-committee on Tests; on Rebonding Clays, on Durability, on Hardness Testing and Mould Permeability, on Core Tests, on Grading, and on Fineness, all Sub-committees of the Moulding-Sand Research Committee. Mr. Saeger has been particularly active, and in large part responsible for the development of the tests for permeability, compression and sintering temperature of moulding sands.

Book Review

A Manual of Foundry Practice. By J. Laing, A.M.I.Brit.F., and R. T. Rolfe, F.I.C. Published by Chapman & Hall, Henrietta Street, London, W.C.2. Price 15s. net.

In the publishers' announcement and preface to this book it is claimed that it fills the gap caused by the change-over of foundry practice from a basis of pure empiricism to scientific control. There has been a great deal of play made with similar statements on this change-over, but, while it is agreed that the metallurgical side of founding is now largely scientific, the moulding side is not scientifically controlled except in the case of large mass-production plants. It is doubtful whether moulding can ever be reduced to an exact science, for it is essentially an art, and whilst text-books on basic principles are extremely valuable, an artist is not made by reading alone. These arguments are borne out by this book, for the authors, rightly, do not give exact figures in many cases, but have to rely on such "rule-of-thumb" expressions as "must not be rammed too hard."

Chapters I to VII on the moulding side of founding are good and, while they are written in a manner capable of being understood by a student, they go into the higher branches of moulding in considerable detail. This part of the book could be very well used as a basis for courses in foundry practice, although the illustrations given are mostly from the point of view of the production of large engine castings, and it deals with other aspects of moulding rather scantily. There are a few notable omissions from this section, such as references to centrifugal castings, calculation of "lift" on cores, core-blowing machines, and design with regard to ease of moulding, while the section on sand testing can hardly be called "scientific." It is also unfortunate that the pattern colouring suggested does not conform in detail with the B.S.I. Specification 467/32.

The metallurgical part of the book does not balance with the earlier part, for it assumes a knowledge of metallurgical terms that would be unfamiliar to a student of the type for which the first chapters are written. The iron-carbon diagram is taken as a basis of the theoretical considerations, and this should have been explained on similar lines. Many metallurgists would disagree with some of the statements on graphitisation, shrinkage, etc., and the importance of total carbon is insufficiently stressed. The chapter on the cupola is fairly good, but maintains a discreet silence on the subject of steel-mix irons and carbon control. There is naturally much sound material in this section of the book, but it hardly lives up to the standard set by the earlier chapters.

Brief mention is made of the special process and alloy cast irons. The authors' experiences with different types of transverse test-bars are very interesting, but out of place in a book of this nature. There is a good, but brief, chapter on non-ferrous founding. The index is fairly complete, but peculiarly arranged; for example, Brinell testing is listed under C—Cast iron, sub-section Testing, sub-section Brinell.

On the whole, the book would be of considerable value to a foundry student, but it can hardly be said to replace the classical text-books on the subject.

P. A. R.

The contract between the Polish Government and the Westinghouse Brake & Saxby Signal Company, Limited, agreed upon in Warsaw at the end of January, was signed in London on Tuesday. The contract, which is for about £4,800,000, is for financing the manufacture and installation of brakes and braking equipment for the Polish railways.

BARROW

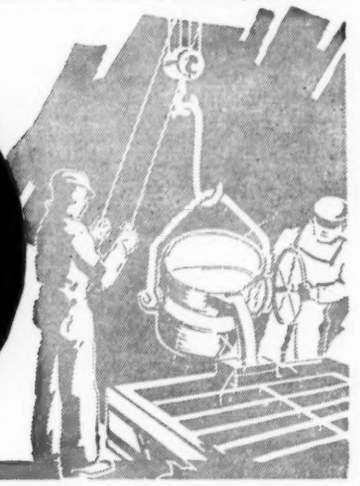
SEMI-PHOSPHORIC PIG IRON

MEETS THE MODERN HIGH TEST REQUIREMENTS OF PRESENT DAY FOUNDRY PRACTICE

WITH MEDIUM PHOSPHORUS CONTENT

ANALYSIS.
Total Carbon 3.50%
Silicon ..... 1.50 to 4.00% as required.
Sulphur ..... .04% maximum.
Phosphorus .10% to .50% in .05% limits.
Manganese ... up to 2.00% as required.

For over 70 years BARROW have been foremost in metallurgical research, hence BARROW Pig Irons have enjoyed ever-increasing popularity and a reputation for quality second to none. This latest development has been specially evolved in response to the demand from iron founders for an iron to ensure FREEDOM FROM POROSITY and extreme toughness. It is now being used in some of the largest foundries with remarkably satisfactory results.



An All-mine Hot-blast Pig Iron which will take a high percentage of scrap in the mixture, it will be found economical in use. Eminently suitable for all castings which are called upon to withstand pressure, e.g., MOTOR CYLINDERS, VALVE BODIES, STEAM and HYDRAULIC CASTINGS, etc.

For your requirements in Hematite and Foundry Pig Irons for all purposes, Refined Open Hearth Cylinder, Heavy Duty and Malleable Irons, apply to:—

THE BARROW HÆMATITE STEEL Co., Ltd.,
BARROW-IN-FURNESS, LANCS.

THE ZIMMERMANN MOULDING MACHINES

●

Important Announcement

All communications concerning these Moulding Machines should be addressed in future to—

ZIMMERMANN MACHINES

37-38, GOLDEN SQUARE, LONDON, W.1.

Telephone: Gerrard 1051.

This Week's News in Brief

Trade Talk

Messrs. Colbond have removed from 24, Martin Lane, Cannon Street, E.C.4, to 37-38, Golden Square, London, W.1.

West of England Refractories, Limited, is being wound up voluntarily. Mr. C. L. Widlake, 9, Paradise Square, Sheffield, is the liquidator.

The English Electric Company, Limited, have received an order from the Bridport Corporation for a 430-kw. Diesel-engined alternator set.

Mr. E. Robinson, 16, Market Street, Newcastle-upon-Tyne, has been appointed liquidator (with a committee of inspection) of the Darlington Rustless Steel & Iron Company, Limited.

A visit to the East Hecla Works of Messrs. Hadfields, Limited, Sheffield, was paid recently by about 20 students from the Royal School of Mines, London.

Three 10-ton battery locomotives for manhaulage underground have been ordered from the Metropolitan-Vickers Electrical Company, Limited, by Messrs. Barber, Walker & Company, Limited, for use at their Harworth pit, Nottinghamshire.

Russian purchases in Great Britain in March were nearly six times those in March, 1933, reports the London office of the Moscow Narodny Bank, the amount being £907,668, in contrast with £151,364. Purchases of machinery and equipment totalled £119,494, against £41,835.

The Low Moor Iron Company, Limited, who are makers of cold-blast and semi-cold-blast pig-iron, wish us to announce that they have no connection whatsoever with the Low Moor Foundry, Limited, which, according to Press announcements, is to be sold by order of the liquidator.

Messrs. Samuel Fox & Company's high-frequency melting plant, which was described in our issue of April 26, is furnished solely with Collin ladles, two of 10 tons, five of 5 tons and three of 2 tons capacity. They have been supplied by John A. Smeeton, Limited, of 15, Victoria Street, London, S.W.1, and comprise the largest Collin ladle-plant installation in any British steelworks.

We are informed by Thos. W. Ward, Limited, of Sheffield, who dismantled the wreck of the "R101" at Beauvais, that only a small quantity (less than 5 per cent.) of the material was sold, by permission of the authorities, to Germany. They cannot understand how the story originated that the new Zeppelin has in her construction a considerable quantity of the framework of the ill-fated British airship.

The Cambridge Instrument Company, Limited, of 45, Grosvenor Place, London, S.W.1, have received an order from Messrs. Improved Metallurgy, Limited, Avonmouth, for a large and comprehensive equipment of temperature recorders, and indicators, for their new plant. The contract includes 20 potentiometric 4-point recorders and two 18-point indicators, all flush-mounted on four steel panels, together with a large number of thermocouples and several other instruments.

It is announced that Dobbie Forbes & Company, ironfounders, Larbert, makers of the well-known "Larbert" portable ranges, have joined Allied Ironfounders, Limited. Mr. J. R. Walker, son of the late Mr. J. Cameron Walker, as well as all leading members of the staff, will continue to be associated with the business, which will be conducted on the lines which have been so successful in the past, and its activities will be further developed by its association with Allied Ironfounders, Limited.

There was a cheerier atmosphere in the Bellshill and Mossend district this week, when about 50 men formerly employed in Messrs. Stewarts and Lloyds' Clydesdale steelworks were invited to attend at the Welfare Institute to interview a representative of the firm from the Tollcross tube works, where large orders for steel tubes are being executed. At present the workers at Tolcross are working extended hours, and it is proposed to adopt an 8-hr. shift. By working three shifts per 24 hrs. it is expected that the 50 men interviewed will be transferred to the Tollcross works in the course of a few days.

Messrs. Colvilles, Limited, have placed an order for the erection at their Clyde Ironworks, Tollcross, of a complete modern electrical precipitation plant for the cleaning of blast-furnace gas as part of a scheme for modernising and extending their facilities for the production of pig-iron. This will be the first gas-cleaning plant to be installed in Scottish works, and the development scheme, when completed, will increase the capacity of the works for manufacturing foundry and steel-making irons. The works will then compare favourably with the best blast-furnace plants on the Continent. The Clyde Iron Works are favourably situated for such a development, as the surplus gases will be conveyed and utilised at the adjacent Clydebridge Steel Works.

Offers submitted by Messrs. William Baird & Company, Limited, and Messrs. William Dixon, Limited, for independent supplies of cheap coke-oven gas were rejected when they came under review by a special committee of Glasgow Corporation. The offer from Messrs. Baird was for 6,250,000 cub. ft. daily and that of Messrs. Dixon for 4,000,000 daily. The cost of producing gas by Glasgow Corporation at present is 5d. per therm delivered into the holders. The offer by the two firms was to provide a supply at 1.75d. per therm, or 8.4d. per cub. ft. A deputation from the Corporation some time ago visited Sheffield, Leeds and other centres in England where gas similar to that offered is in use.

Following the announcement last week of the resignations of Mr. Charles Mitchell and Mr. B. Walmsley from the board of Messrs. Dorman, Long & Company, Limited, it is officially stated that in connection with the reorganisation of the company further changes have been resolved upon. The board has decided that the vacant office of chairman will not be filled until after the reorganisation of the company has taken place. The company has surrendered its lease of its present London office in Broadway, Westminster, and is removing to Terminal House, Victoria, S.W.1, where it is expected the company will be installed by May 1. It has definitely been decided that the control of the whole business will be centred in Middlesbrough. For this purpose Mr. Laurence Ennis, the managing director, will shortly take up residence in Middlesbrough and will be in active control of the business from there as from May 1. The duties of the general manager and comptroller will be taken over by him from this date and these appointments abolished. Mr. W. F. Prentice has relinquished the office of general manager and has been appointed general sales manager from the same date. Mr. S. W. Rawson will continue to serve the company as secretary.

Obituary

Mr. Charles Lynex, malleable ironfounder, of Walsall, died recently, in his 76th year.

The death occurred, on April 24, of Mr. James Christie, who had been for many years manager of the Motherwell Foundry Company, Limited, Shields Foundry, Flemington, Motherwell.

The death occurred, on April 24, of Mr. Donald Nicholson. Mr. Nicholson, who was 77 years of age, retired a few years ago from the employment of Messrs. Walker Hunter & Company, Limited, Port Downie Iron Works, Falkirk, after 58 years' service with the firm.

The death occurred unexpectedly, on April 26, of Mr. James Denny, the well-known Clyde engineer and shipbuilder. He was the second son of Mr. James Denny, shipbuilder, of Levenford, one of the early members of the firm of Denny Bros. & Company, Limited, Dumbarton. He served his apprenticeship in the firm's engine works, and the whole of his business life was spent there, although latterly he was also closely identified with the shipyard in the capacity of chairman of directors of the associated firms. Mr. Denny, who was in his 85th year, became a partner of the engine works in 1871 and of the shipyard in 1907, and when he retired from the chair in 1919, his long connection with shipbuilding had made him one of its representative men. His work as an engineer will be specially recalled in his connection with the introduction of the Parsons marine turbine, and he presided at the launch of the "King Edward," the first passenger turbine steamer. Mr. Denny spent the whole of his life promoting the interests of his firm and of his native town.

New Companies

Forge Engineering Works, Limited.—Capital £100. Ironfounders, mechanical engineers, etc. Permanent directors: F. D. Playford, Orchard Court, Hook, Surrey; B. N. R. Lamont.

Hopyard Foundries, Limited, Siddons Road, Coseley, Staffs.—Capital £6,000. Malleable steel and iron founders. Life directors: S. Allen, L. A. Lloyd, A. Allen and L. R. Lloyd.

C. H. Broughton (1934), Limited.—Capital £1,000. To take over the business of ironfounders carried on at Mill Lane, Brighouse, as C. H. Broughton's Successors. Director: H. Barraclough.

Thomas Richards & Sons, Limited, Bristol.—Capital £8,000. Ironfounders. Directors: E. B. Richards and A. B. Richards.

Security Patent Anchor Company, Limited, 6, Great Marlborough Street, London, W.1.—Capital £1,500. Ironfounders, manufacturers of implements and machinery. Directors: Prof. G. I. Taylor and A. E. Ingham.

Injection Moulders, Limited, Greycourt House, Greycourt Street, Westminster, S.W.1.—Capital £4,000. Manufacturers of, and dealers in, machinery and accessories for the moulding industry. Directors: A. G. Dowding and O. W. G. Doll.

Company Reports

Thomas Firth & John Brown, Limited.—Balance from trading account, including income from investments, £161,017; profit, after meeting debenture and other interest, £102,519; to depreciation reserve, £90,000; carried forward, £17,882.

Stewarts and Lloyds, Limited.—Profit for 1933, £615,876; depreciation, £156,324; brought in, £156,738; interim dividends on preference shares, £49,875; to special depreciation reserve, £30,000; income tax reserve, £65,000; employees' benefit reserve, £10,000; general reserve, £150,000; dividends for half-year ended December 31, 1933, on the cumulative first, second and third preference shares, £51,537; dividend for year of 6d. per share on 4,626,740 deferred shares, and on 625 liaison deferred shares, each of which carries rights to dividend equivalent to those attaching to 1,000 deferred shares, at the same rate, £101,752; carried forward, £158,125.

Personal

Mr. John T. Batey, managing director of Messrs. R. & W. Hawthorn, Leslie & Company, Limited, Hebburn-on-Tyne, has been elected President of the North-East Coast Institution of Engineers and Shipbuilders, following in succession to Mr. R. J. Walker.

Wills

Crosbie, J. P., formerly a director of Messrs. Hadfields, Limited, Sheffield	£32,903
Tucker, W. F., for many years secretary of the Lilleshall Company, Limited, Shifnal, Salop	£10,734
Clement, W. F., of Barrow-in-Furness, chief engineer to the Barrow Hematite Steel Company, Limited	£2,458
Dalrymple, William, late of Ayr, and manager of the Dalmellington Iron Company, Limited, and connected with Bourtreehill Coal Company, Limited	£48,364

Contracts Open

Argentina, May 15.—Centrifugal pumping sets, for the Argentine State Oilfields Directorate. The Department of Overseas Trade. (Reference G.Y. 13,720.)

Great Chesterford, May 11.—372 tons of 5-in., 4-in. and 3-in. cast-iron pipes and specials, for the Saffron Walden Rural District Council. Messrs. Sands & Walker, Milton Chambers, Nottingham. (Fee £3, returnable.)

Sheffield, May 7.—Tramway rails, for the Transport Department. Mr. A. R. Fearnley, general manager, Division Street, Sheffield.

Johannesburg, May 19.—Centrifugal pumps, piping and valves, for the City of Johannesburg. The Department of Overseas Trade. (Reference G.Y. 13,705.)

XUM

Wm. CUMMING & Co., Ltd.,

Ironfounders' Facings Manufacturers and General Foundry Furnishers,

Kelvinvale Mills, Maryhill, Glasgow.

Branches at Falkirk, Chesterfield, Deepfields and Middlesbrough.

The Leading Manufacturers. The Oldest Established. The Most Reliable.

SUPERFINE COALDUST

SUPERLATIVELY REGULAR IN GRIST
SUPERIOR IN QUALITY
SEVEN GRISTS STANDARDISED
ONE QUALITY OF COAL THROUGHOUT

IMPROVED INGOT MOULD BLACKING

THE BEST ON THE MARKET
MANUFACTURED BY THE NEW PROCESS

BRITISH PLUMBAGOS

AT LOW PRICES
IMPORTED DIRECT
NO CONTINENTAL ADULTERATIONS

CORE COMPOUNDS, CUMMINGSTONE, PARTING POWDER, AND BLACKINGS

ALL OF OUR OWN MAKE

USERS OF THE NEW

CUMMING FURNACE

ARE INCREASING WEEK BY WEEK

Wm. CUMMING & Co., Ltd.,

GLASGOW, FALKIRK, CHESTERFIELD, DEEPFIELDS and MIDDLESBROUGH.

Raw Material Markets

Export business in iron and steel is still very limited, but there is a good volume of business at command in the home market, and prices remain firm. The demand for pig-iron remains heavy, and is sufficient to absorb the current output. More active conditions are reported in the steel trade, many of the works having heavy bookings. Big tonnages of semis, in particular, are going into consumption.

Pig-Iron

MIDDLESBROUGH.—Cleveland pig-iron is still very difficult to sell overseas, in spite of the price concessions offered by the ironmasters. Practically the whole output is being absorbed by the home markets, however, and there is no sign of any falling off in this direction. New business is not, perhaps, coming forward as quickly as it might, but this is largely the effect of stabilised prices, consumers seeing little necessity to commit themselves far ahead. For such iron as they require, however, they are unhesitatingly paying the fixed zone prices, which for No. 3 Cleveland G.M.B. pig-iron are 67s. 6d. per ton delivered in the Middlesbrough area, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow.

There are nine blast furnaces producing hematite on the East Coast. The make is well absorbed, in spite of slightly smaller shipments to South Wales and Europe. Heavy deliveries are still being made to Sheffield and the Midlands, and the renewal of a number of large contracts is expected shortly. For foreign sales about 61s. per ton has been accepted for East Coast mixed numbers, but the fixed zone prices are exacted for all home sales. These are based upon No. 1 hematite at 68s. per ton delivered in the Middlesbrough area, 70s. delivered Durham and Northumberland, 74s. to 77s. delivered Yorkshire, 75s. delivered Scotland and 76s. delivered Lancashire.

LANCASHIRE.—Ironmasters supplying foundry pig to this area report that deliveries have a tendency to expand, and that contracts are running their course more quickly than has been the case for some years. The outlook is regarded as definitely improved. The general price position is much the same as before. For delivery to users in the Widnes district, Staffordshire, Derbyshire and North-East Coast brands of No. 3 are quoted on the basis of 72s. 6d. per ton, but for delivery in other Lancashire areas the figure is 1s. 6d. more; Northamptonshire iron is on a 72s. 6d. basis, with Derbyshire forge at 69s. to approved users and a minimum of 70s. to foundries. Scottish pig-iron makers report little improvement in the volume of business in the Manchester district, due largely to the continued competition from Indian brands, and current offers for delivery equal to Manchester are at about 83s. per ton. West Coast hematite also meets with a moderate demand only in this area at about 80s. 6d. per ton, delivered, with East Coast hematite in fair request at from 75s. to 76s. per ton, according to grade.

MIDLANDS.—The light foundries in this area remain busy, with several months' work in front of them, and they are taking good deliveries of foundry iron. Special grades, and also common iron for the general ironfounders, are in increasing demand. There was a meeting of the Central Pig-iron Producers' Association last week, but no changes affecting the South Staffordshire area were made, so that the controlled prices applicable to Birmingham and Black Country stations remain at 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Staffordshire and Lincolnshire No. 3. These figures bear a graduated rebate to large consumers of iron. As regards special grades, low-phosphorus iron is offered at 81s. to 85s. per ton, medium-phosphorus at 70s. to 80s., and refined iron at £5 15s. to £6 15s. per ton, while moderate quantities of Scottish iron are entering this area at about 87s. 6d. delivered Midland stations. There have been no changes in the prices of hematite, and the market is quiet.

"Zone" prices have now been arranged for Midland pig-irons in the South Wales area. Details are given on this page.

SCOTLAND.—New business is slow. Few orders are coming to hand for Scottish pig-iron, which is unchanged in price, No. 3 being at the official figure of 70s. per ton f.o.r. furnaces, with 2s. 6d. extra for No. 1. The call for the latter is very limited. Business remains good in the light-castings section of the foundry trade, and satisfactory deliveries are being taken of locally-made iron to the English analysis, in addition to the usual regular supplies of Cleveland. The latter is quoted at 67s. 3d. f.o.r. Falkirk and 70s. 3d. f.o.r. Glasgow, one or two contracts having been made up to the end of the year.

Coke

Conditions are unchanged in the foundry-coke market. Prices remain firm, and the makers are not particularly anxious to book beyond the third quarter, although many consumers would go further if they could. Current quotations are:—Best Durham coke, 36s. 6d. to 40s.; Welsh, 36s. to 45s., according to analysis; Scottish low-ash quality, 41s. per ton; delivered in the South Staffordshire area.

Steel

Business in the steel markets is maintained at the recently improved rate, and any price changes which have occurred have been in an upward direction. The most disappointing feature of the situation is that export business is expanding very slowly owing to the restrictions on exchange dealings and other difficulties which hamper business in overseas markets. In the semi-finished steel market the demand has become somewhat lighter, and the producing works have no difficulty now in keeping abreast of deliveries. This is partly due to the expansion in production and also to the fact that a number of the largest consumers have covered their requirements for some time ahead. Business in finished steel is on a good scale, and most of the works are well employed, principally on orders from home consumers. The heavy steelworks are turning out a large tonnage of steel for the shipyards, and the demand from the general engineering industries is improving. Competition in the export markets from Continental works appears to be increasing, but it is not serious in the home trade.

Scrap

Prices are unchanged in the Cleveland scrap market, heavy metal being at 50s. and machinery metal at 53s., but merchants are looking for an early advance. Steady conditions rule in the Midlands, scrap quotations remaining stable. In South Wales there is a slightly better demand for heavy cast iron, at 47s. 6d. to 48s. 6d., machinery scrap and light cast-iron scrap also being more active at 47s. 6d. to 48s. 6d. per ton and 42s. 6d. per ton respectively. In Scotland, machinery cast iron, suitable for foundries, is at 57s. 6d., with ordinary cast at 55s.

Metals

Copper.—Dealing in copper has been rather restricted during the past week. The demand from consumers in this country has remained steady, and the outlook in this direction is good, as stocks at many works are reported to have fallen rather low. The position with regard to the new American code, which came into operation as from April 26, is still obscure, as full details of the code's provisions have not yet come to light. At the moment, the market is more or less hanging fire. Stocks of copper in the United States are still very large, but recently there have been reports of small reductions being made, and it is hoped that this movement will be pushed further as consumption improves.

Daily quotations :—

Cash.—Thursday, £33 3s. 9d. to £33 5s.; Friday, £32 16s. 3d. to £32 17s. 6d.; Monday, £32 17s. 6d. to £32 18s. 9d.; Tuesday, £32 15s. to £32 17s. 6d.; Wednesday, £32 17s. 6d. to £32 18s. 9d.

Three Months.—Thursday, £33 8s. 9d. to £33 10s.; Friday, £33 1s. 3d. to £33 2s. 6d.; Monday, £33 1s. 3d. to £33 2s. 6d.; Tuesday, £33 to £33 1s. 3d.; Wednesday, £33 1s. 3d. to £33 2s. 6d.

Tin.—The tinplate manufacturers in South Wales are only moderately well occupied at the moment, but increased outputs continue to be recorded on the Continent and in America. The motor industry continues to be well employed, however, and the world consumption of tin has been making a gradual upward movement. Supplies in this country have been gradually decreasing, and a good premium has prevailed for any supplies available for early delivery.

A further decrease occurred during April in the world's visible supply of tin, of over 2,500 tons. It was expected that a small increase would be made in the export quotas at yesterday's meeting of the International Tin Committee.

Market prices :—

Cash.—Thursday, £240 5s. to £240 10s.; Friday, £237 15s. to £238 10s.; Monday, £238 12s. 6d. to £238 17s. 6d.; Tuesday, £238 10s. to £238 15s.; Wednesday, £238 10s. to £238 15s.

Three Months.—Thursday, £237 15s. to £238; Friday, £235 10s. to £236; Monday, £235 15s. to £236; Tuesday, £235 10s. to £235 15s.; Wednesday, £236 to £236 5s.

Spelter.—Conditions affecting this market are unaltered. The brass manufacturers are busy and are taking good tonnages of metal, but the galvanising trade is still in an unsatisfactory state. Dealing has been rather quiet this week. Consumers have been taking slightly more interest in "remelted" spelter.

Day-by-day prices :—

Ordinary.—Thursday, £14 18s. 9d.; Friday, £14 17s. 6d.; Monday, £14 18s. 9d.; Tuesday, £14 16s. 3d.; Wednesday, £14 16s. 3d.

Lead.—As the building season advances, the demand for lead and lead products becomes more active. Plentiful supplies are available, however, and prices remain at a comparatively low level. The United States statistics for March, recently published, show that unsold lead stocks rose during that month by 5,000 short tons, to over 221,000 tons.

Market fluctuations :—

Soft Foreign (Prompt).—Thursday, £11 10s.; Friday, £11 7s. 6d.; Monday, £11 7s. 6d.; Tuesday, £11 8s. 9d.; Wednesday, £11 7s. 6d.

Midland Pig-Iron in South Wales

ZONE SYSTEM OF PRICES ESTABLISHED

The South Wales district has now been brought within the scheme of price control for Midland brands of pig-iron. At last week's meeting of the Central Pig-iron Producers' Association plans were approved for dividing the market in South Wales and the South and West of England into six zones, and the application to each of delivered prices.

The South Wales district and adjacent areas have for some years been outside the price control, and it was felt that in view of the virtual elimination of foreign competition this differentiation should no longer remain. The following is a list of the new zones, with the basis prices now payable for No. 3 foundry iron:—

Zone F, including Wells, Warminster, Trowbridge, Radstock and Westbury, Northants pig-iron 75s., Derbyshire 78s. 6d.

Zone G, including Portland, Yeovil, Exeter, Taunton and Bridgwater, Northants 77s. 6d., Derbyshire 81s.

Zone H, including Plymouth, Barnstaple, Launceston, Truro and Falmouth, Northants 81s. 6d., Derbyshire 85s.

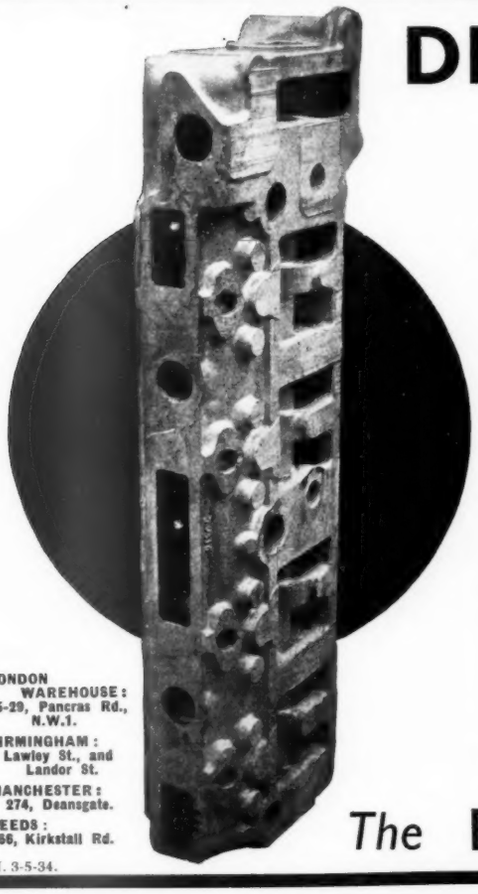
Zone I, including Newport, Pontypool, Cwmbran and Blaenavon, Northants 72s. 6d., Derbyshire 76s.

Zone J, including Cardiff, Pontypridd, Merthyr, Swansea, Llanelly and Carmarthen, Northants 74s., Derbyshire 77s. 6d.

Zone K, including Fishguard, Haverfordwest and Cardigan, Northants 78s. 6d., Derbyshire 81s.

As a result of the zoning of the area buyers will have to pay a substantially higher price than has prevailed under free market conditions. Other grades of iron will be in the normal relation to No. 3. There are no changes in prices for other areas, the existing rates having been reaffirmed.

AT THE MEETING of the Kirkintilloch Dean of Guild Court, last week, Messrs. Cameron & Roberton, Limited, Southbank Ironworks, were granted lining for an extensive alteration and addition to the works. The plans make provision for the erection of a new three-storey pattern store, a new moulding shop, gatehouse garages, etc., as well as alteration and rearrangement of the present moulding shops.



DIESEL ENGINE CYLINDER HEAD

in "HIDUMINIUM" R.R. 50

(aluminium alloy)

This casting, with a length of 3 ft. 6 ins., weighs 60 lbs. Aluminium alloys are used in this application principally for their high thermal conductivity.

(Photograph is shown by courtesy of High Duty Alloys Ltd., Slough, Bucks.)

ALUMINIUM AND LIGHT ALLOYS

The BRITISH ALUMINIUM CO. Ltd.

HEAD OFFICE: ADELAIDE HOUSE, KING WILLIAM ST., LONDON, E.C.4.
TELEPHONE MANSION HOUSE 5561 & 8074 (5 LINES) TELEGRAMS: CRYOLITE, BILGATE, LONDON

- LONDON WAREHOUSE: 25-29, Pancras Rd., N.W.1.
- BIRMINGHAM: Lawley St., and Landor St.
- MANCHESTER: 274, Deansgate.
- LEEDS: 66, Kirkstall Rd.

F.T.J. 3-5-34.

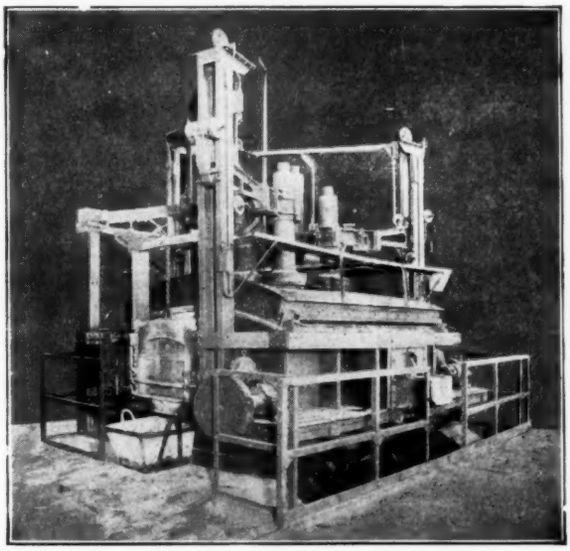
The BRITISH ALUMINIUM COMPANY Ltd.

GREAVES-ETCHELLS ELECTRIC STEEL FURNACES

MORE THAN 100 FURNACES SUPPLIED DURING LAST 7 YEARS.

WATSON ROTATING ELECTRIC FURNACES Ensure RAPID & CLEAN MELTING

THOROUGH MIXING.



NON-FERROUS METAL MELTING ELECTRIC FURNACES

SINGLE, TWO, or THREE PHASE.

CONTRACTORS TO HOME AND FOREIGN GOVERNMENTS.

WATSONS (METALLURGISTS) LIMITED

Adelaide Works, Mowbray Street, SHEFFIELD, 3.

RAW MATERIALS—PRICE LIST

(Wednesday, May 2, 1934)

COPPER

	£ s. d.
Standard cash	32 17 6
Three months	33 1 3
Electrolytic	35 15 0
Tough	34 15 0
Best selected	35 5 0
Sheets	62 0 0
India	44 5 0
Wire bars	36 0 0
Ingot bars	36 0 0
H.C. wire rods	38 5 0
Off. av. cash, April	33 10 10½
Do., 3 mths., April	33 5 8¼
Do., Sttlmnt., April	33 0 10½
Do., Electro, April	36 5 9
Do., B.S., April	36 3 1½
Do., wire bars, April	36 10 9
Solid drawn tubes	10d.
Brazed tubes	10d.
Wire	6½d.

BRASS

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8⅜d.
Rods, extd. or rlld.	4½d.
Sheets to 10 w.g.	7½d.
Wire	7⅜d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	238 10 0
Three months	236 0 0
English	239 5 0
Bars	240 5 0
Straits	240 15 0
Australian	240 10 0
Eastern	239 10 0
Banca (nom.)	242 0 0
Off. av. cash, April	239 6 0
Do., 3 mths., April	237 13 8½
Do., Sttlmt., April	239 6 3

SPELTER

	£ s. d.
Ordinary	14 16 3
Remelted	15 0 0
Hard	12 5 0
Electro 99.9	17 10 0
English	15 10 0
India	14 5 0
Zinc dust	19 0 0
Zinc ashes	3 5 0
Off. aver., April	15 1 1⅞
Aver. spot, April	14 18 3¾

LEAD

	£ s. d.
Soft foreign ppt.	11 7 6
Empire	11 13 9
English	12 15 0
Off. average, April	11 12 11½
Average spot, April	11 10 0

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	23 10 0
Do., V.M. ex whse.	23 0 0
Rods	29 0 0

ANTIMONY

	£ s. d.
English	42 0 0 to 43 0 0
Chinese, ex-whse.	36 0 0
Crude	25 0 0

QUICKSILVER

	£ s. d.
Quicksilver	10 10 0 to 10 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£8 17 6
45/50%	£13 0 0
75%	£18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten—	
80/85%	2/9 lb.
Tungsten metal powder—	
98/99%	3/- lb.
Ferro-chrome—	
2/4% car.	£32 0 0
4/6% car.	£23 0 0
6/8% car.	£21 12 6
8/10% car.	£21 12 6
Ferro-chrome—	
Max. 2% car.	£36 5 0
Max. 1% car.	£38 15 0
Max. 0.70% car.	£42 0 0
70% carbon-free	10½d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	2 13 6	to 2 15 0
Bundled steel and shrngs.		2 7 6
Mixed iron and steel	2 8 0	to 2 10 0
Heavy cast iron	2 7 6	to 2 8 6
Good machinery	2 10 0	to 2 12 6
Cleveland—		
Heavy steel		2 7 6
Steel turnings		1 17 6
Cast-iron borings		1 7 6
Heavy forge		2 10 0
W.I. piling scrap		2 5 0
Cast-iron scrap	2 10 0	to 2 13 0
Midlands—		
Light cast-iron scrap		2 7 6
Heavy wrought iron		3 0 0
Steel turnings, f.o.r.		1 12 6
Scotland—		
Heavy steel	2 10 0	to 2 12 6
Ordinary cast iron		2 15 0
Engineers' turnings		2 2 6
Cast-iron borings	2 1 3	to 2 2 6
Wrought-iron piling	2 11 3	to 2 12 6
Heavy machinery		2 17 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	27 0 0
Brass	19 10 0
Lead (less usual draft)	10 10 0
Tea lead	8 0 0
Zinc	9 10 0
New aluminium cuttings	70 0 0
Braziery copper	24 0 0
Gunmetal	25 0 0
Hollow pewter	155 0 0
Shaped black pewter	110 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	68/-
Hematite M/Nos.	67/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	80/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	74/-
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	72/6
Cleveland fdry. No. 3	74/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 12 6	to 9 15 0
Nut and bolt iron	7 5 0	to 8 0 0
Hoops	10 10 0	to 12 0 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	10 10 0	to 12 0 0
Bolts and nuts, ⅜ in. × 4 in.		13 15 0
Steel—		
Plates, ship, etc.	8 15 0	to 8 17 6
Boiler plts.	8 2 6	& up.
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5½ in.		9 7 6
Rounds under 3 in. to ⅜ in. (Untested)		8 12 0
Flats—8 in. wide and over		8 12 6
,, under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0	to 8 10 0
Fishplates	12 5 0	to 12 10 0
Hoops (Staffs)	10 10 0	& up.
Black sheets, 24g. (4-t. lots)		10 10 0
Galv. cor. shts. (,,)		13 0 0
Galv. flat shts. (,,)		13 10 0
Galv. fencing wire, 8g. plain		14 10 0
Billets, soft		5 10 0
Billets, hard	6 17 6	to 7 2 6
Sheet bars	5 0 0	to 5 5 0
Tin bars		5 0 0

PHOSPHOR BRONZE

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12d.
Rods	11d.
Tubes	15d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.50
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	38.00
	Cents.
Iron bars, Phila.	1.89
Steel bars	1.90
Tank plates	1.85
Beams, etc.	1.85
Skelp, grooved steel	1.70
Steel hoops	1.85
Sheets, black, No. 24	2.65
Sheets, galv., No. 24	3.25
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.10
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 27/6
,, furnace	20/-
Durham foundry	21/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	17/- to 17/6
,,	28×20 ,,	34/- to 35/-
,,	20×10 ,,	24/3 to 24/6
,,	18¾×14 ,,	17/9 to 18/-
C.W.	20×14 ,,	15/- to 15/3
,,	28×20 ,,	31/3 to 31/6
,,	20×10 ,,	21/6 to 21/9
,,	18¾×14 ,,	15/3 to 15/6

SWEDISH CHARCOAL IRON & STEEL

	£ s. d.	£ s. d.
Pig-iron	£6 0 0	to £7 0 0
Bars-hammered, basis	£16 0 0	to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0	to £16 0 0
Blooms	£10 0 0	to £12 0 0
Keg steel	£30 0 0	to £31 0 0
Faggot steel	£18 0 0	to £23 0 0
Bars and rods dead soft, st'l	£10 0 0	to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
April	26 ..	33 3 9	dec. 1/3
,,	27 ..	32 16 3	,, 7/6
,,	30 ..	32 17 6	inc. 1/3
May	1 ..	32 15 0	dec. 2/6
,,	2 ..	32 17 6	inc. 2/6

Electrolytic Copper

		£ s. d.	
April	26 ..	36 5 0	No change
,,	27 ..	36 0 0	dec. 5/-
,,	30 ..	35 15 0	,, 5/-
May	1 ..	35 15 0	No change
,,	2 ..	35 15 0	,, ,,

Standard Tin (cash)

		£ s. d.	
April	26 ..	240 5 0	dec. 7/6
,,	27 ..	237 15 0	,, 50/-
,,	30 ..	238 12 6	inc. 17/6
May	1 ..	238 10 0	dec. 2/6
,,	2 ..	238 10 0	No change

Tin (English ingots)

		£ s. d.	
April	26 ..	241 0 0	No change
,,	27 ..	238 10 0	dec. 50/-
,,	30 ..	239 5 0	inc. 15/-
May	1 ..	239 5 0	No change
,,	2 ..	239 5 0	,, ,,

Spelter (ordinary)

		£ s. d.	
April	26 ..	14 18 9	dec. 1/3
,,	27 ..	14 17 6	,, 1/3
,,	30 ..	14 18 9	inc. 1/3
May	1 ..	14 16 3	dec. 2/6
,,	2 ..	14 16 3	No change

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
April	26 ..	17 11 3	No change
,,	27 ..	17 10 0	dec. 1/3
,,	30 ..	17 10 0	No change
May	1 ..	17 10 0	,, ,,
,,	2 ..	17 10 0	,, ,,

Zinc Sheets (English)

		£ s. d.	
April	26 ..	24 0 0	No change
,,	27 ..	24 0 0	,, ,,
,,	30 ..	23 10 0	dec. 10 -
May	1 ..	23 10 0	No change
,,	2 ..	23 10 0	,, ,,

Lead (English)

		£ s. d.	
April	26 ..	13 0 0	No change
,,	27 ..	12 15 0	dec. 5/-
,,	30 ..	12 15 0	No change
May	1 ..	12 15 0	,, ,,
,,	2 ..	12 15 0	,, ,,

AVERAGE PRICES OF GALVANISED CORRUGATED SHEETS (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1904	11 5 0	11 5 0	11 5 0	11 5 0	10 15 0	10 15 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	10 5 0	10 15 0
1905	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	10 7 6	11 0 0	11 5 0	11 15 0	12 0 0	10 15 0
1906	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 7 6	12 12 6	12 12 6	12 15 0	12 15 0	12 15 0	13 5 0	12 11 11½
1907	13 5 0	13 5 0	13 15 0	13 15 0	13 15 0	13 15 0	13 17 6	13 17 6	13 17 6	13 2 6	13 2 6	13 2 6	13 10 10
1908	13 2 6	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 11 0½
1909	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 16 8
1910	11 15 0	12 5 0	12 5 0	11 15 0	11 10 0	11 10 0	11 12 6	11 12 6	11 12 6	11 12 6	11 10 0	11 10 0	11 18 4
1911	11 5 0	11 1 3	10 15 0	10 15 0	10 13 9	10 10 0	10 13 9	11 0 0	11 5 0	11 5 0	11 5 0	11 7 0	10 19 7½
1912	11 10 0	11 10 0	11 10 0	11 15 0	12 5 0	12 5 0	12 5 0	12 5 0	12 5 0	12 12 6	12 18 0	12 15 0	12 2 11½
1913	12 15 0	12 15 0	12 15 0	12 11 3	11 18 0	11 15 0	11 15 0	11 15 0	11 15 0	11 3 0	11 0 0	11 2 6	11 18 4
1914	11 7 0	11 7 6	11 7 6	11 5 7½	11 2 6	10 15 0	10 15 0	12 17 6	14 2 0	13 7 0	11 15 7	11 2 6	11 16 0
1915	11 10 8½	13 12 6	14 8 9	15 0 6	17 17 6	20 17 6	20 17 6	20 6 3	17 12 6	18 1 0	22 13 9	25 2 0	19 3 4½
1916	26 5 0	27 12 6	28 0 0	28 5 0	29 0 0	29 0 0	28 15 0	28 3 0	28 15 0	28 15 0	28 15 0	28 15 0	28 6 8½
1917	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 15 0	28 0 0	28 0 0	28 0 0	28 11 3
1918	28 5 0	28 15 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	29 0 0	28 13 4
1919	29 0 0	29 0 0	29 0 0	28 0 0	28 10 0	27 7 6	27 5 0	29 3 0	32 0 0	33 0 0	36 10 0	40 8 4	31 5 3½
1920	46 10 0	49 15 0	53 15 0	56 0 0	54 10 0	52 10 0	52 10 0	48 10 0	44 3 4	39 2 6	35 17 6	30 8 0	47 4 3
1921	23 10 0	25 17 6	24 5 0	23 3 4	22 0 0	22 0 0	23 10 0	21 12 6	20 0 0	18 15 0	18 3 9	17 2 0	22 1 7
1922	16 17 6	15 13 9	16 3 0	16 10 0	16 4 4½	15 15 6	15 16 3	16 16 0	16 8 9	16 6 3	17 1 0	17 7 6	16 7 5½
1923	18 3 1½	19 1 11½	19 8 0	19 10 0	19 7 0	19 1 3	18 0 0	18 13 1½	19 0 0	19 3 9	19 2 6	18 19 4½	18 19 2
1924	18 13 6	18 9 4½	18 5 0	17 15 11½	17 3 0	17 19 4½	18 7 6	18 8 1½	18 8 1½	17 19 6	17 11 3	17 10 0	18 0 10½
1925	17 8 6	17 1 6½	16 9 4½	16 12 0	16 9 8½	16 9 4½	16 0 6	16 1 10½	16 5 0	16 7 0	16 12 6	16 15 0	16 11 0½
1926	16 14 4½	16 5 7½	16 0 6	15 11 10½	15 11 3	16 0 0	16 16 0	16 18 9	16 14 0	16 18 9	17 10 0	16 19 0	16 10 0½
1927	16 3 1	15 7 6	15 3 3	15 3 1½	14 14 4½	14 11 6	14 1 10½	14 0 0	13 19 6	13 16 10½	13 13 1½	13 3 9	14 9 10
1928	13 0 0½	13 2 6	13 6 0	13 2 6	13 3 0	13 6 9	13 11 3	13 10 0	13 10 7½	13 12 6	13 11 6	13 10 0	13 8 8½
1929	13 11 0	13 13 1½	13 12 9½	13 10 11½	13 9 3	13 8 9	13 11 6	13 7 6	13 7 6	13 5 6	12 18 9	12 12 9½	13 7 5½
1930	12 5 0	11 15 0	11 19 6	11 18 7	11 18 0	11 17 6	11 17 6	11 17 6	11 16 3	11 12 6	11 8 9	11 5 0	11 15 11½
1931	11 4 0	11 0 0	11 0 0	11 0 0	10 13 9	9 18 9	9 13 0	9 5 3½	8 19 0½	9 16 0	9 8 9	9 4 0½	10 1 10½
1932	9 2 9	9 14 4½	9 16 0	9 13 9	9 12 6	9 12 6	9 11 0	9 4 4½	9 11 3	10 12 6	11 5 0	11 7 0	9 18 7
1933	11 15 0	11 15 0	11 15 0	11 15 0	11 17 6	12 4 0	12 10 0	12 10 0	12 12 6	12 15 0	12 15 0	12 15 0	12 4 11
1934	12 15 0	12 15 0	12 15 0	12 17 6	—	—	—	—	—	—	—	—	—

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK
LUMPEX

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-
(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOUNDRYMAN. Malleable and Grey Iron. Keen worker with commercial, technical and practical experience is open to take a progressive post with a foundry anxious to develop repetition methods. Practical expert in the production of metal patterns and coreboxes, constructed and cast pattern plates in all metals, composition and plaster plates and oddsides, and pattern sprays. Conversant in the erection, maintenance and setting-up of all types of moulding and core-blowing machines, also mechanised processes.—Box 738, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2

MIDLAND Firm of Ironfounders engaged on repetition work require services of Foundryman able to control men and obtain maximum possible production economically. Salary secondary consideration to obtain right man, to whom progress to directorship is offered, particularly if desirous of taking up purchase of shares on appointment.—Apply, Box 728, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

METALLURGICAL Chemist, age 30, requires position. Experience in general analytical work associated with iron and brass founding and engineering works practice. Practical metal-melting and research. (243)

PRACTICAL Foundry Manager, age 48, is open for re-engagement; 14 years' successful operation of large, well-known ironfoundries; thoroughly experienced in all classes of engineering and pipe work and capable of taking full control. Excellent testimonials. (244)

FINANCIAL

GENTLEMAN of 30 years' foundry experience would be prepared to invest or take shares in foundry or engineering business of good, sound reputation.—Box 732, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY

MAGNIFICENT
11 ACRES WORKS SITE.
SHEFFIELD.
145,000 Sq. Ft. of Shops.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—
THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD

TENDER

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

THE Metropolitan Water Board invite Tenders for the supply of the undermentioned Stores and Services for periods of 6 and 12 months commencing June 1, 1934 :—

Tender No.
1.—Bricks, Firebricks, Cement, etc.
8.—Iron and Steel.
9.—Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, etc.
12.—Fuel Oil, Oil (Lubricating), Kerosene, Motor Spirit, Greases, etc.
19.—Iron, Brass, Gunmetal and other Castings.
20.—G.M. Stopcocks and Ferrules, Outlets and Caps for Fire Hydrants.
22.—Timber.
23.—Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained from the Acting Chief Engineer by personal application at the Offices of the Board (Room 155) or upon forwarding a stamped addressed envelope (large).

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board" and endorsed in the manner indicated in the Form of Tender, must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Wednesday, May 16, 1934.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery Avenue, E.C.1.
April 30, 1934.

MACHINERY

FOR Sale, Cupolette by Evans, Manchester: Tilting type, with Belt-driven Fan.—Box 736, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SAND-BLAST PLANTS AND AIR COMPRESSORS
(Tilghman's).
We have in stock :—
15 NEW SAND-BLAST PLANTS.
20 Re-conditioned Sand-blast Plants.
120 NEW AIR COMPRESSORS.
22 Re-conditioned Air Compressors.
All sizes—all pressures.
Sand blasting and Metal-spraying for all Trades.
R. J. RICHARDSON & SONS, LIMITED, COMMERCIAL STREET, BIRMINGHAM, 1.

GERBER
IS ALWAYS BUYER
for cash of
ELECTRIC MOTORS AND POWER PLANT
of every description.
J. GERBER & CO., LTD.,
15, MOORFIELDS, LONDON, E.C.2.

THOS. W. WARD LTD.

Battery of two good W.I.F. type W.T. BOILERS (Babcock & Wilcox, 1921), each Boiler of 3,091 sq. ft. heating surface, single steam drum about 24' long x 4' 6" dia., 140 tubes about 18' long. With Superheater of 550 sq. ft. heating surface, constructed for a working steam pressure of 180 lbs. per sq. in. Complete with usual steam and furnace fittings and mountings, etc.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).
ALBION WORKS, SHEFFIELD.

MACHINERY—*Continued*

FOR Sale, No. 2 "Titan" Cupolette mounted on standards, with Belt-driven Fan; nearly new; all complete.—Box 730, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

SANDBLAST PLANTS
Room, Rotary Barrel and Cabinet Types complete; 12 in stock.

SAND PLANT
Sand Mills, 6-ft., 5-ft. and 4-ft. 6-in. dia. Pans.
Rotoil "Senior" Oil Core Sand Mixer.
Pneulec Sand Drying Plant, output 1 ton per hour.
Brearley Type Disintegrators.

MOULDING MACHINES
Hand and Pneumatic Types.
Also
Six Rowlands Double-ended Grinders for 24-in. dia. x 2-in. wheels.
Electrical and Belt-driven Blowers and Exhaust Fans, Ladles, etc., etc.

AIR COMPRESSORS
All sizes for high and low pressures.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1934 edition now ready. Price 42s. cloth bound, 52s. morocco. Order *YOUR* copy *NOW*.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

MISCELLANEOUS

PATTERNS.—Inferior Patterns make trouble in the foundry. Why not buy the best—they cost very little more.—Send to FURMSTON & LAWLOR, Letchworth, Herts.

HARDWOOD CORE BOXES, dowelled and varnished, ready for use, made to order in all lengths and variety on shortest notice. HARDWOOD MALLETS also a speciality.—WILLIAM OLSEN, LIMITED, Cogan Street, Hull.

TIME RECORDERS (workpeople): guaranteed; must clear.—Box 734, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 287 SLOUGH

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories **£290 Nett.**

T.B. 1 Tilghman sandblast barrel plant, complete. CHEAP.

T.B. 3 Tilghman sandblast barrel plant, double-jet, complete. CHEAP.

6' "Jackman" rotary sandblast table. CHEAP seen working.

SAND PLANT

Herbert "Whizzer" type disintegrator, No. 1 **£30**
Rotary Sand Dryer by Titan **£55**
Pneumatic riddle, by Macdonald **£8**
Large "Baillott" sand preparing plant CHEAP.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH